Abstracts

IL-1

Rotational osteotomies of the lower limb - an update on diagnostics, normative values, rationals and surgical techniques

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Rotational osteotomies of the lower limb are well-established procedures in pediatric, orthopedic, and trauma surgery. In recent years, advances in patellofemoral surgery have further renewed attention to this topic and are of particular interest in sports-trauma surgery. Normative values for femoral and tibial torsion are well documented and can be reliably reproduced using various measurement techniques. A novel aspect in current practice is the inclusion of knee version - the intra-articular rotational alignment of the knee joint - into both diagnostic assessment and surgical decision-making. The increasing use of magnetic resonance imaging (MRI) and the development of dedicated torsional measurement software have further enhanced diagnostic accuracy. Moreover, these software tools offer a significant advantage in terms of standardized and objective medicolegal documentation.

Attempts have also been made to localize the level of torsional deformity, allowing for separate assessment of supra- and infratrochanteric torsion of the femur, as well as supra- and infratuberositary torsion of the tibia. The rationale for determining the optimal level of osteotomy - whether proximal, diaphyseal, or distal at the femur or tibia - remains a matter of ongoing debate and has evolved in recent years. These developments have also influenced implant selection and surgical technique. Specialized derotational plates are now available, and there is a growing trend toward diaphyseal torsional osteotomies stabilized with intramedullary nails. This approach allows for minimal-invasive procedures and facilitates early full weight bearing, if not additional lengthning over a self-distracting nail is needed. Complex rotational / multidimensional deformities close to a joint or with soft tissue problems still are the domain of a graduated correction with Hexpod-Fixators.

IL-2

Inverted V-shaped High Tibial Osteotomy: A Promising Alternative to Conventional Techniques for Severe Varus Knee OA

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Introduction
The inverted V-shaped HTO (iVHTO) is defined as a combination of hemi-LCW and hemi-MOW osteotomy, in which bone chips from the resected lateral wedge are immediately grafted into the medial opening gap (*CORR* 2006). Recently, the iVHTO procedure fixed using a locking compression plate (*Arthrosc Tech*, 2018) has gained attention as a potentially useful option for treating medial osteoarthritic knees with severe varus deformity. In 2022, an editorial entitled “An iVHTO May Have Advantages” (C. Servant, Associate Editor) was published in *Arthroscopy*, highlighting the following potential benefits of iVHTO over conventional HTO procedures: (1) clinical advantages of immediate bone grafting; and (2) theoretical advantages of a neutral osteotomy over other types. However, the editorial identified several unresolved issues regarding iVHTO: (1) limited clinical evidence supporting its potential advantages, and (2) the need for fibular shortening osteotomy. To address these concerns, we conducted a series of clinical studies. In this lecture, I will present the published findings and discuss their implications.

Study 1 (OJSM, 2025)
A total of 109 knees were followed up with CT after undergoing iVHTO. The progression of bone healing could be classified into 3 types: Type 1 (direct healing), Type 2 (indirect healing), and Type 3 (delayed healing). The incidences of Types 1, 2, and 3 were 75.2%, 18.3%, and 6.4%, respectively. In Type 1 and Type 2 knees (n = 102), the time to achieve bone union averaged 11.0 weeks. There were no complications other than several cases of delayed union.

Study 2 (under review)
A total of 109 knees were followed up for 3 to 6 years after undergoing iVHTO and divided into two groups based on the correction angle: Group S (8–12 degrees) and Group L (13–19 degrees). No significant differences were observed between Groups L and S in bone union time (12.7 vs. 12.4 weeks), complication rate (4.1% vs. 3.3%), knee function scores, or KOOS. Larger corrections performed using the iVHTO procedure did not delay bone healing, increase complication rates, or worsen clinical outcomes.

Study 3 (AJSM 2022)
Three- to six-year outcomes were compared between iVHTO (n = 113) and MOWHTO (n = 107). Patellar baja and increased posterior tibial slope were significantly observed in the MOW group, whereas these parameters remained unchanged in the iV group. PF joint congruity was significantly improved only in the iV group. Although preoperative TF and PF osteoarthritis was more severe in the iV group than in the MOW group, no significant differences in knee scores were observed between the two groups.

Study 4 (Arthrosc Tech 2018, OJSM 2022)
We developed a safe and simple fibular shortening technique, termed the acute oblique osteotomy and ligation procedure. A total of 231 knees were followed up for 2 years. Complications included only 3 cases (1.3%) of nonunion. A bone union rate of 98.7% was observed, with an average time of 7.0 months. This technique has proven effective in minimizing the clinical adverse effects of fibular osteotomy.

DISCUSSION
MOWHTO is effective for mild varus osteoarthritic knees. In severe cases requiring large corrections, however it often leads to complications such as hinge fractures. Therefore, alternative HTO procedures should be used for such severe knees to minimize these risks. Although LCWHTO has been used in such cases, it carries a high risk of complications distinct from those associated with MOWHTO, such as delayed union. Our studies show that iVHTO enables early bone union with fewer complications and does not induce patella baja or alta, regardless of the correction angle. This procedure offers a promising alternative to conventional techniques for treating advanced osteoarthritic knees with severe varus deformity.

SL-1

Complication management of osteotomies around the knee

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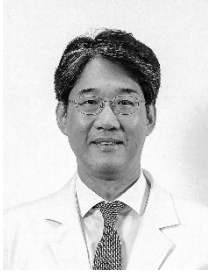
Several studies have pointed out that HTO is frequently associated with various types of complications during or after surgery. Martin et al (AJSM 2014) reported classifications for adverse events in OW-HTO as follows: Class 1 events were considered those that required no additional treatment or minor alterations in postoperative care; Class 2 required additional or extended nonoperative treatment for a limited period of time; and Class 3 required either long-term medical treatment or additional surgery. Using their system, we categorized complications as minor (Class 1) or major (Classes 2 and 3).
Yabuuchi et al (OJSM 2020) reported that patella baja (Caton-Deschamps index <0.6) was observed in 38% of cases in OW-HTO. Lateral hinge fractures occurred in 29%. Increased tibial length (>10 mm) was observed in 27%. Implant failure (screw breakage) occurred in 10%. 2% had superficial infections. Unacceptable overcorrection, correction loss (>5°), increasing posterior tibial slope (PTS >10°), and nonunion occurred in 1-2%. In the patient with overcorrection or nonunion, we performed revision HTO. In the patients with correction loss and increased PTS, TKA was performed. The cumulative rate of all complications was 41%. However, the rate of major complications was 25% (Class 2:15%, Class 3: 9%).
On the other hand, several investigators have indicated that the complication rate of the CW-HTO is high, such as delayed union, nonunion, correction loss, peroneal nerve palsy, hematoma, and compartment syndrome. In addition, the length of the lower limb decreases after surgery. The bone mass is reduced in the proximal tibia, resulting in difficulty of potential TKA. Therefore, an alternative HTO procedure without these disadvantages should be developed for knee OA with moderate or severe varus deformity. We have developed the inverted V-shaped HTO (iV-HTO), which is classified as a Neutral Wedge osteotomy (hemi-closing and hemi-opening), is a potential HTO procedure to solve these disadvantages (Aoki et al JBJS-Br 2006). Namely, in this procedure, the center of tibial alignment correction of the HTO is located approximately at the center of rotation of angulation (CORA) of the lower limb deformity. According to the principle of the bone deformity correction, it is expected that this procedure does not affect the patellar height, tibial length, or bone mass of the tibial plateau. We reported that no patients had superficial and deep infections (Kondo et al AJSM 2022). Unacceptable overcorrection occurred in 1%, correction loss in 1%, and nonunion in 3%. In the 3 patients with unacceptable overcorrection or nonunion, we performed revision iV-HTO and iliac bone graft by use of bilateral plate fixation. Recently, Yabuuchi et al (OJSM 2025) demonstrated that the progression of bone healing at the osteotomy site after iV-HTO could be classified into 3 types: Type 1 (direct bone healing), Type 2 (indirect bone healing), and Type 3 (delayed bone healing). The incidences of Types 1, 2, and 3 were 75%, 18%, and 6%, respectively. Therefore, more recently, we have developed a modified iV-HTO procedure fixed with bilateral locking compression plates. Concerning fibula osteotomy, we have also developed an acute oblique osteotomy and ligation procedure for the center of the fibular shaft. This procedure significantly accelerated the formation of bridging callus at the fibular osteotomy site and provided a higher union rate (Yasuda et al Arthrosc Tech 2020, Ueda et al OJSM 2022).
These results indicate that the HTO procedure is a technically demanding procedure, although the overall clinical results were good. Careful preoperative planning and meticulous surgical technique are needed to decrease the incidence of complications associated with HTO.

SL-2



Next Generation Plate for Knee Osteotomy – Continuous Drive for Improvement

Kang-il Kim

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Open-wedge high tibial osteotomy (HTO) is a well-established treatment for knee osteoarthritis, particularly in young, active patients. Since the TomoFix plate was introduced in 2003 by the AO Task Force, the angle-stable locking plate has become the gold-standard implant for medial opening-wedge HTO, enabling early weight-bearing and rapid functional recovery. Despite substantial long-term outcome improvements with angle-stable fixation, clinical challenges remain — including anatomical fit, enhanced mechanical stability, and precision in achieving correction targets. The next-generation plating system for Knee Osteotomy was developed in partnership with AOTK across the Asia–Pacific region, the next generation plating system for knee osteotomy is specifically designed to better meet the needs of the Asian population.

This session presents the development journey and highlights the key improvements of the next generation plating system.

LS1-1

Current topics in high tibial osteotomy

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Although high tibial osteotomy (HTO) is an established procedure for treating medial compartment osteoarthritis in the varus knee, several important challenges remain, and these issues continue to shape the evolution of modern osteotomy practice.

One ongoing debate concerns the clinical relevance of increased joint line obliquity (JLO). Biomechanical studies suggest that excessive JLO may alter load distribution across the knee and increase tensile forces on the posterior root of the lateral meniscus. However, its true clinical significance remains uncertain.

Another challenge involves the accuracy of osteotomy surgery. Even experienced surgeons may encounter discrepancies between planned and achieved corrections, including variability in coronal alignment and unintended changes in posterior tibial slope. New technologies such as patient-specific instrumentation (PSI) have been introduced in an effort to address these accuracy limitations and improve reproducibility.

Preoperative planning has also become increasingly demanding, particularly with the growing use of double-level osteotomy. Artificial intelligence (AI)–based planning tools have emerged as a promising adjunct, capable of assisting with automated deformity analysis and suggesting appropriate surgical strategies. By reducing the manual burden of planning, AI has the potential to enhance consistency and support decision-making.

Posterior tibial slope (PTS) represents another critical parameter because of its influence on anterior tibial translation and anterior cruciate ligament (ACL) strain. Increased PTS is associated with a higher risk of ACL injury and graft failure, making slope-reducing osteotomy an important consideration in selected patients. The tibial plateau has distinct medial and lateral slopes with different biomechanical roles, and it remains unclear which contributes more substantially to ACL strain. A better understanding of these differences will be essential for developing future surgical strategies.

LS1-2

Osteotomies for knee ligament instability: When, Why and How?

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Knee ligament instability can be treated by ligament reconstruction. Some patients have mal-alignment associated with or without osteoarthritic (OA)) conditions at the time of treatment for ligament instability and the influence of mal-alignment on the outcomes of ligament reconstruction has been reported.

For coronal alignment, varus of > 5 degrees has been suggested as surgical indication for osteotomy in the treatment of chronic posterolateral corner injury. Conversely, surgical indication for varization osteotomy for valgus knees remains elusive despite several biomechanical studies have shown that valgus alignment increases medial collateral ligament and anterior cruciate ligament (ACL) graft stresses. Therefore, osteotomy can be considered based on the severity of lateral OA associated with chronic ligament-deficiency.

For sagittal alignment, the influence of posterior tibial slope (PTS) on outcomes of ACL reconstruction has been a recent topic in recent years. In previous studies, there was a tendency recurrence of instability or re-injury after ACL reconstruction increases in patients with PTS of >12 degrees. Therefore, slope-reducing osteotomy may be necessary at the time of revision surgeries. In our clinical cases, patients with an increase of PTS of >12 degrees had a higher re-injury rate than those with PTS <12 degrees after ACL reconstruction similar to previous studies, suggesting that PTS is an important factor for graft survival after ACL reconstruction although surgical indication for osteotomy is still debatable and a caution may be necessary to avoid possible complications. Slope-reducing osteotomy can be performed simultaneously or as two-step surgery using different osteotomy techniques. In this presentation, the current topic of osteotomy in ligament instability is summarized and discussed.

LS2

Analysis of whole limb alignment using hip-to-calcaneus radiograph

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Analyzing the true mechanical axis of the lower limb as a line from the center of the femoral head to the lowest point of the calcaneus using a full-length standing posteroanterior radiograph that includes the calcaneus (hip-to-calcaneus radiograph) clarifies the pathogenesis of various hindfoot disorders. Such analysis also facilitates surgical planning. Further, the analysis can clarify the cause of an unsatisfactory outcome of corrective surgery in particular cases. Knee realignment surgery influences hindfoot alignment and vice versa. I believe it essential to analyze alignment of the whole limb when planning reconstructive surgery for lower limb conditions involving malalignment.

AS1

Characteristics, Indications, and Complications of the Oxford UKA — Why Not Include the Oxford in Your Arsenal?

Hidetoshi HAMAGUCHI

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While osteotomy remains a central theme in knee joint preservation strategies, unicompartmental knee arthroplasty (UKA) offers a compelling alternative for select patient populations. HTO preserves the native joint—but sometimes preserves the pain as well. Its clinical outcomes tend to decline after 10 years. The Oxford Partial Knee (Oxford UKA: OUKA) is a mobile-bearing unicompartmental knee arthroplasty system with over 40 years of clinical history. In this seminar, I will outline the key characteristics, surgical indications, and common complications associated with OUKA, along with practical strategies for their management.

The most notable advantage of OUKA is its excellent long-term survivorship—over 90% at 20 years. This durability is supported by two structural features:

A spherical articulation between the femoral component and the bearing surface, providing a large contact area.
A freely mobile tibial bearing that allows physiological knee kinematics while offering high wear resistance.
From a technical standpoint, the procedure benefits from the Microplasty instrumentation system, which enables precise bone cuts and fine gap adjustments in 1 mm increments using a milling technique.

The most significant complication is bearing dislocation. Because the underlying causes are often difficult to identify, many surgeons remain overly cautious about adopting OUKA. However, by gaining a clear understanding of the mechanisms and preventive strategies for dislocation, surgeons can overcome this “Oxford allergy” and establish reliable indications and techniques that lead to favorable outcomes.

A major focus of this seminar will be a detailed discussion on how to avoid complications associated with OUKA. I sincerely hope this will empower more surgeons to choose OUKA with confidence.

AS2-1

New surgical technique to reinforce the function of the meniscus -Meniscal circumferential fiber augmentation-

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The knee meniscus is a tissue that plays an important role in the knee joint, including load distribution, shock absorption, joint stability, and joint lubrication. Meniscus injuries can be broadly divided into traumatic injuries and age-related degeneration. In either case, a decrease in load distribution function places excessive stress on the cartilage, causing cartilage degeneration and contributing to the development of osteoarthritis. The meniscus' load distribution function is primarily carried out by collagen fibers called circumferential fibers, and the mechanism by which this C-shaped tissue structure distributes load like a cushion is called the hoop function. Among the various types of injury, injuries that result in loss of hoop function, such as transverse tears, increase the risk of developing osteoarthritis due to increased cartilage contact pressure, and are extremely difficult to treat because most of the injury involves the avascular area of the meniscus. Circumferential meniscal fiber augmentation, newly developed in 2022, is a biomechanical and anatomical surgical procedure that artificially reinforces the hoop function of the meniscus by inserting an artificial ligament into the meniscus along the circumferential fibers of the meniscus. This procedure completely differs from conventional methods of directly suturing the damaged area. Previously, the torn area was repaired using only sutures, but with this procedure, the torn area is pulled together by applying tension to the artificial ligament, making the torn area extremely stable. Approximately 3 years have passed since this procedure began, and we are beginning to see intraoperative findings and results not seen in clinical practice to date, such as the ability to suture even injuries that were previously deemed impossible to suture. In this presentation, we will introduce the new meniscal repair procedure, circumferential meniscal fiber augmentation, and discuss its short-term results and future prospects.

AS2-2

Dual-Tunnel Pullout Repair for medial meniscus posterior root tear: Unpublished Insights and Common Pitfalls

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When a medial meniscus posterior root tear (MMPRT) occurs, tibiofemoral contact pressure increases to a level comparable to that seen after total meniscectomy, leading to rapidly progressive medial meniscus extrusion (MME) and subsequent osteoarthritic changes. To address MME more effectively, we developed a novel surgical method—the Dual-Tunnel Pullout (DTP) technique—based on the concept of meniscotibial ligament (MTL) augmentation. One tunnel is used for MMPRT pullout and the MTL augmentation suture, while the other tunnel is used for the opposite end of the MTL augmentation suture.

This technique eliminates the need for anchors and avoids the risk of anchor failure, while allowing stronger and more reliable tensioning, even in patients with lower bone mineral density. Another key feature is that it reinforces the MTL and restores meniscal stability without requiring an intrameniscal suture. By distributing the loading forces applied to the repaired posterior root during weight bearing and/or knee flexion, the DTP technique may promote healing of the repaired root. By reducing MME, enhancing meniscal stability, and decreasing mechanical strain on the repair site, the DTP technique also enables the safe implementation of early rehabilitation protocols.

In this presentation, I will discuss MMPRT pathology, clinical outcomes, surgical indications, the development of the DTP technique, and pearls and pitfalls.

DS-1

Pitfalls and Technical Tips in Around Knee Osteotomy Learned from Early Experience

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Around Knee Osteotomy (AKO) has become an essential surgical option for early-stage knee osteoarthritis and meniscal injuries. Unlike total knee arthroplasty, only a limited number of institutes perform a high volume of AKO procedures, and beginners often face significant barriers when overcoming the learning curve. The fundamental techniques include distal femoral osteotomy (DFO) for femoral deformity, open-wedge high tibial osteotomy (OWHTO) for tibial deformity, and hybrid closed-wedge HTO (h-CWHTO) for cases with flexion contracture, large correction angles or posterior tibial slope, or patellofemoral joint osteoarthritis.

I began performing AKO in earnest relatively recently, in 2017, and have encountered numerous pitfalls during the process. The first key point is proper surgical indication. Although advanced osteoarthritis, older age, female sex, and obesity are known risk factors for poor outcomes, AKO remains a viable option in patients who do not present with multiple unfavorable factors. The second critical issue is achieving accurate postoperative alignment. The target weight-bearing line (WBL) ratio is typically 55–70%, depending on the patient-specific intra-articular condition. However, most preoperative planning relies on two-dimensional templating, and postoperative soft-tissue balance may alter alignment beyond bony correction alone, making it difficult to achieve the planned correction precisely. This challenge is particularly pronounced in closed-wedge procedures such as CWHTO and DFO, where intraoperative fine-tuning is limited, increasing the risk of over- or under-correction.

As with any surgery, neurovascular injury is an unacceptable complication and requires meticulous intraoperative attention. In this seminar, I will present the pitfalls encountered during my early experience with AKO and the strategies employed to overcome them. I hope this session provides experts with an opportunity to revisit the fundamentals and reflect on their own initial learning experiences.

DS-2

Early stage knee osteoarthritis and medial meniscus extrusion-treatment according to lower limb alignment

○Mitsuaki Kubota, Haruka Kaneko, Keiichi Yoshida, Shinnosuke Hada, Yougji Kim, Hitoshi Arita, Jun Tomura, Jun Shiozawa, Yoshitomo Saita, Muneaki Ishijima

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Knee osteoarthritis (KOA) is a national disease, because there are 25 million patients of KOA in Japan. According to population aging, healthy life expectancy is essential, therefore, it is important to prevent knee osteoarthritis through early treatment interventions. Early stage KOA cannot be diagnosed by X-rays, and even if patients complain of pain, it is often ignored. MRI is a useful tool to detect early stage KOA, and also finds many kinds of factors of KOA (meniscus and cartilage injury, synovitis, bone marrow lesion). Medial meniscus extrusion (MME) is a specific meniscus injury correlated with early stage KOA. The clinical results of treatment of MME are influenced by lower limb alignment. We will talk about early stage KOA and MME according to lower limb alignment.

ES-1

Patient-Specific Instrumentation in Knee Preservation Osteotomies

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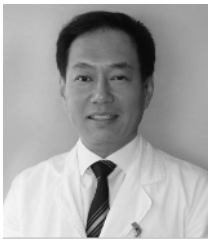
-Introduction/Purpose
Knee osteotomy is an effective joint-preserving procedure for deformity correction in active patients with unicompartmental osteoarthritis or post-traumatic malalignment. However, traditional two-dimensional planning and freehand techniques can result in inaccurate correction, prolonged operative time, and increased radiation exposure. Patient-specific instrumentation (PSI), generated from three-dimensional preoperative planning, has emerged as a method to improve precision and reproducibility in both high tibial osteotomy (HTO) and distal femoral osteotomy (DFO). Tibial condylar valgus osteotomy (TCVO) additionally addresses intra-articular deformity that cannot be corrected through extra-articular osteotomy alone. This work summarizes the clinical applications, radiologic outcomes, and biomechanical advantages of PSI-assisted osteotomies in knee preservation surgery.

-Material and Methods
This report includes clinical case analyses and imaging follow-up of patients undergoing medial open/closed-wedge HTO, DFO, double osteotomy, and TCVO assisted by PSI. Preoperative deformity parameters—including weight-bearing line percent (WBL), medial proximal tibial angle (MPTA), mechanical lateral distal femoral angle (mLDFA), joint-line convergence angle (JLCA), posterior tibial slope (PTS), and limb length—were evaluated through 2D and 3D planning. PSI cutting guides and drilling guides were designed to translate virtual planning to intraoperative execution. Outcomes assessed included correction accuracy, postoperative alignment, joint congruity, clinical scores, and second-look arthroscopy findings. A retrospective review of 39 PSI-assisted MOWHTO cases with two-year follow-up was also summarized, focusing on correction error, surgical efficiency, and complication profile.

-Results
PSI-based surgical planning demonstrated high precision in reproducing target angles. In 39 PSI-assisted MOWHTO cases, the correction error was 0.1° ± 1.7° (95% CI: −0.5° to 0.6°), confirming excellent accuracy and a low outlier rate. PSI use reduced operative time, minimized fluoroscopic exposure, and shortened the learning curve for surgeons performing both standard and double-level osteotomies.
TCVO was effective in patients with intra-articular deformity, including depression of the medial tibial plateau and lateral tibial thrust. TCVO improved limb alignment, restored joint congruity, and enhanced pain and functional scores in patients with severe varus knees or prior trauma-related deformities. Postoperative radiographs demonstrated improved MPTA and mLDFA, reduction of JLCA, and restoration of WBL toward neutral alignment. Follow-up arthroscopy in selected MOWHTO patients revealed cartilage regeneration in the medial compartment following accurate mechanical correction.

-Conclusion
PSI combined with 3D planning significantly improves the accuracy, safety, and reproducibility of knee osteotomy procedures. It provides reliable translation of preoperative targets into postoperative alignment while reducing radiation and operative complexity. TCVO offers additional advantages in correcting intra-articular deformities that cannot be addressed by extra-articular osteotomy alone. The integration of PSI into HTO, DFO, and TCVO enhances surgical outcomes and supports knee preservation in patients with complex deformities, including those with trauma-related malalignment. Continued development of PSI design and expanded clinical follow-up will further refine its role in modern osteotomy surgery.

ES-2



1st line conservative treatment of MM root tear and 2nd line operation

Kyung Wook Nha

Professor & Chairman, Department of Orthopaedic Surgery, Inje University Ilsan Paik Hospital, Korea

I reviewed about 354 patients with degernative MM root tear(MMPRT) from 2011 to 2025 year to investigate clini cal results & X ray of conservative treatment retrospectively. There were 87 men and 267 women at a median a ge of 57 years old (range 51- 75). 1st conservative treatments included 1) Hyalunonic acid injection (3 times/ 3 month) and NSAID drugs for 3 months and 2) educate the patients to stop of squating position and 3) to cane wa lking for 1 month and to stop active exercise for 1 months, because of relief of antinflammatory stage in MMPRT. My theory of knee proceed the degenarative change of meniscus and cartilage and bone osteoprosis in old age and proceed bowing of femur neck and shaft, even though surgeon performed the MMPRT pullout suture or cent ralization, it will be bowing of knee joint and than proceed medial osteoarthritis and medial meniscus subluxation. If the conservative treatment was failed after 3 months, I will try MMPRT pullout suture, HTO or TKA according t o age, X ray, MRI. Before the conservative Treatment until 2010, I preformed AS meniscetomy, AS direct repair, open posterior Pullout suture, or HTO. I reviewed articles, there was all changes of medial osteoarthritis in AS M MPRT pullout suture and clinical good result. My data in conservative treatment was same of change the medial osteoarthritis and clinical good result (maybe 80- 90%)

In conclusion, My 1st line treatment is consevatinve treatment for 3 months (3 options) than operation, It will provided pain relief in MMPRT patients

SY1-1

Effects of Correction Angle and Joint Line Obliquity on Knee Biomechanics in Open Wedge High Tibial Osteotomy

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Purpose: This study determined the ideal coronal alignment under dynamic conditions after open-wedge high tibial osteotomy (OWHTO).
Materials and Methods: Musculoskeletal computer models were analyzed with various degrees of coronal correction in OWHTO, with the mechanical axis passing through points at weight-bearing line (WBL) 40%, 50%, 60%, 62.5%, 70%, and 80% of the tibial plateau from the medial edge. Osteotomy models with medial proximal tibial angles (MPTAs) ranging from 90 degree to 97 degree in 1-degree increments were also developed while maintaining identical coronal alignment with WBL 62.5%.
Results: The classical alignment with WBL62.5% achieved sufficient load on the lateral tibiofemoral joint and maintained normal knee kinematics after OWHTO. However, overcorrection with WBL80% caused an excessive lateral load and non-physiological kinematics; abnormal contact between the medial femoral condyle and the medial intercondylar eminence of the tibia occurred at knee extension. Larger MPTAs, even with WBL62.5%, caused excessive increases in medial tibiofemoral contact forces, and the dominant tibiofemoral contact forces shifted to the medial side. Models with large MPTAs also showed nonphysiological roll-forward of the lateral femoral condyle during squatting.
Conclusion: The classical target alignment demonstrated validity in OWHTO. Excessively large MPTAs resulted in increased medial tibiofemoral contact forces and abnormal k
nee kinematics.

SY1-2

Postoperative MPTA as the primary determinant of KJLO following AKO

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In the stance phase, equivalent to single-leg weight-bearing, it is essential for the KJLO to be parallel to the ground in functional biomechanics. In AKO, the postoperative MPTA plays the most dominant role in determining KJLO.For patients with low activity demands, whose primary goal is pain relief in daily life, achieving a horizontal KJLO may not be clinically crucial. However, for physically active individuals in their 40s to 60s who wish to return to sports and recreational activities at a higher level, surgeons should aim to avoid restricting activity as much as possible. Considering that the femoral head is nearly spherical, compensatory function at the hip is minimal. Although the AJLO has a compensatory ability influenced by the varus tilt of the tibial shaft, it remains unclear whether KJLO inclination should be compensated for by AJLO.In this presentation, we compare cases of OWHTO based on postoperative MPTA (>95° vs. <95°) and subsequently report our recent clinical experience with DLO, focusing on verticalization of the tibial shaft and the restoration of horizontal KJLO and AJLO.

SY1-3
Joit line obliquity after double level osteotomy

○Hiroshi Nakayama, Tomoya Iseki, Shintaro Onishi, Soong Junwei, Hiroki Miya, Akira Kawai, Toshiya Tachibana,

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In recent years, joint line obliquity (JLO) after knee osteotomy has been recognized as a condition to be avoided because it increases shear forces across the articular surface. However, accurate prediction of postoperative JLO remains challenging, and mMPTA is currently the only practical indicator available.
In our department, for knees with severe varus deformity, we have performed double-level osteotomy (DLO) when the preoperative planning shows an mMPTA > 95°. Among cases with a JLCA < 4°, distal tuberosity tibial osteotomy was performed on the tibial side. We retrospectively reviewed 22 patients (31 knees) with a minimum follow-up of 2 years.
At 2 years postoperatively, the mean mLDFA and mMPTA were 86.3° and 89.6°, respectively, both within normal anatomical ranges, and no significant changes were observed after 2 months postoperatively. These findings suggest that DLO can achieve and maintain favorable anatomical alignment without inducing JLO from 2 months to 2 years after surgery.

SY1-4
Avoiding Excessive Joint Line Obliquity after High Tibial Osteotomy: The Importance of Preoperative Deformity Analysis.

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Excessive joint line obliquity (JLO) after high tibial osteotomy (HTO) has been reported to increase shear stress and contact pressure, resulting in a non-physiological knee joint. However, the clinical relevance of JLO and the acceptable range of postoperative medial proximal tibial angle (MPTA) remain controversial.We previously demonstrated that a postoperative MPTA ≥95° did not adversely affect clinical outcomes after open-wedge HTO (OWHTO). Despite a substantial increase in postoperative MPTA, knee joint line obliquity (KJLO) increased only minimally, and clinical outcomes were comparable regardless of postoperative MPTA. These findings suggest that compensatory mechanisms at the hip and ankle can maintain a near-horizontal joint line even when MPTA slightly exceeds 95°.However, such compensation may be insufficient in patients with preoperative femoral varus deformity. Preoperative mechanical lateral distal femoral angle (mLDFA) has been identified as a key determinant of postoperative JLO, and HTO in these patients may result in excessive JLO, correction loss, and inferior long-term outcomes. Therefore, surgical procedure selection should be based on comprehensive preoperative deformity analysis, including mLDFA, rather than postoperative MPTA alone.

SY1-5

What Is the Meaning of the Joint Line Obliquity in Osteotomy?

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This presentation consists of following contents: 1. Joint line & Alignment in Knee OA Surgery 2. Nature of the HTO 3. Definition & Characteristics of JLO 4. Serial Change of JLO 5. Cons & Pros on increased JLO. Knee surgery is heading for acceptable alignment and joint line. As you know, TKA in advanced OA, main trend is shifting to the personalized approach. In this trend, CPAK plays a major role and it is characterized by arithmetic HKA angle and joint line obliquity. Joint line obliquity is important as limb alignment to restoring natural kinematics. On the view point of the JLO, after HTO, it may be ideal to shift as type V or VI that is mild valgus alignment and neutral JLO. Type IX may be JLO. HTO combines 3 D changes that have possibility of other compartmental change. Joint line obliquity can be managed by DLO. However, “when do we have to do the DLO” and “how much JLOs are acceptable” is not well established. Excessive large corrections can cause unfavorable outcome. Why does JLO appear? Increase in MPTA is often unavoidable because mild overcorrection is recommended to prevent recurrence. In addition, valgization osteotomy leads to femoral adduction and hence, more lateral JLO. However, relationship between the degree of correction and changes in JLO is not so simple. If then, what is the meaning of JLO? There is no consensus on how to measure JLO or on which radiographs should be used. Joint line orientation angle by femoral condyle, by middle knee joint space, by tibial plateau. D is medial proximal tibial angle and E is angle between middle knee joint space line and lower limb weight bearing line. Joint line is line along the tibial plateau. MPTA is angle between tibia plateau and tibial mechanical axis. JLO is, originally, the inclination between joint line and limb’s mechanical axis. However, narrowly, in HTO articles, as reverse obliquity. It means inclination of the plateau to the tibial mechanical axis. Nearly same to the MPTA or confused with JLOA. JLOA is an angle to the ground, emphasizing its’ dependence on the pts’ positioning. Increased JLO causes the femur to “slide down hill” across the tibial plateau, shift in joint contract pressure from the medial to lateral side. It induces the contralateral limb to minimize the displacement of the body center and consequently reduces body energy expenditure. After HTO, expected rotation of the foot around this angulation correct axis occurs, after then, foot position should be restored just lateral to the midline by adduction of the hip. Therefore, real JLOA can be accentuated. On the serial change of JLO, KJLO increased up to 1 year, then, decreased and correlated with adaptive changes of the hip adduction angle and ankle JLO. In addition, alignment changes of the unilateral OWHTO and primarily treated limb of the bilateral OWHTO were associated with the JLOA change of the contralateral limb. SR on KJLO to clinical outcome, conflicting findings between postoperative KJLO and PROMs. Actual association can’t be ascertained and clinical relevance of KJLO after HTO remains controversial. In conclusions, certain amount of joint line change will be inevitable in HTO. However, excessive change is likely to be bad, and at least not good. Therefore, it will be important to analyze the deformity and predict change to make a flexible choice. In osteotomy, several parameters of a similar concept to JLO are being used in confusion. Accurate understanding and use of JLO will lead to an accurate assessment of it.

SY1-6

Changes of Knee Joint and Ankle Joint Orientations after Medial Opening-wedge High Tibial Osteotomy

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Purpose:
Medial opening-wedge high tibial osteotomy (MOWHTO) is a well-established procedure for the treatment of medial compartment knee osteoarthritis associated with varus malalignment. By realigning the mechanical axis toward the lateral compartment, MOWHTO effectively redistributes load and alleviates medial knee pain. However, this correction inevitably alters the coronal plane alignment of both the knee and ankle joints. Excessive postoperative knee joint line obliquity (KJLO) has been suggested to cause abnormal joint loading and potentially inferior clinical outcomes, yet its actual clinical significance remains controversial. This study aimed to evaluate whether postoperative knee joint line obliquity (KJLO) influences clinical outcomes after medial opening-wedge high tibial osteotomy (MOWHTO) and to identify compensatory alignment factors, particularly at the ankle joint. In addition, we assessed whether ankle clinical outcomes and radiographic parameters are affected following MOWHTO.

Method:
We retrospectively reviewed patients who underwent MOWHTO between May 2016 and September 2022 and had a minimum follow-up of at least 2 years. Demographic characteristics, pre- and postoperative radiographic parameters, and patient-reported outcome measures (PROMs) were analyzed. Radiographic assessments included the weight-bearing line ratio (WBL%), hip–knee–ankle (HKA) angle, medial proximal tibial angle (MPTA), lateral distal tibial angle (LDTA), knee joint line obliquity (KJLO) relative to the ground, and ankle joint line obliquity (AJLO) relative to the ground, measured on full-length standing lower-limb radiographs. Clinical outcomes of the knee and ankle were compared pre- and postoperatively. Multivariable linear regression analyses were performed to identify factors associated with postoperative KJLO and clinical outcomes.

Result:
A total of 67 patients (23 men and 44 women) who underwent MOWHTO were included. The mean age at surgery was 57.78 ± 6.86 years, and the mean follow-up period was 47.38 ± 19.24 months. Significant radiographic corrections were achieved postoperatively in WBL%, MPTA, HKA, AJLO, and KJLO (all $p < 0.001$). Knee-related clinical outcomes significantly improved, with lower VAS pain scores and higher IKDC and WOMAC scores postoperatively ($p < 0.001$). Postoperative KJLO ≥ 4° was not significantly associated with worse clinical outcomes. In the regression model, changes in AJLO ($\beta = -0.271$, $p = 0.028$) were negatively correlated with changes in KJLO, suggesting compensatory distal realignment at the ankle. No significant changes were observed in ankle VAS scores, indicating that ankle clinical outcomes were not adversely affected.

Conclusion:
KJLO ≥ 4° was not associated with worse postoperative function. Compensatory changes at the ankle, changes in AJLO before and after MOWHTO, mitigated excessive joint line obliquity, helping maintain overall limb balance. Although MOWHTO causes significant radiographic alterations in lower limb alignment, these changes did not deteriorate ankle clinical outcomes.

SY2-1

Knack and Pitfalls of Hybrid closed wedge high tibial osteotomy (HCWHTO)

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Open-wedge high tibial osteotomy (OWHTO) has become the most common surgical procedure for treating medial compartment osteoarthritis of the knee due to its relatively simple surgical technique and favorable clinical outcomes. However, OWHTO has certain limitations in cases requiring large angular correction or those complicated by patellofemoral (PF) osteoarthritis. In such cases, the procedures such as open-wedge distal tuberosity tibial osteotomy (OWDTO) or HCWHTO are recommended.

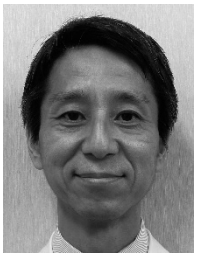
HCWHTO is a closed-wedge osteotomy that incorporates the advantages of open-wedge surgery and accommodates a various type of knee deformity and clinical symptom. Although the procedure requires fibular osteotomy, proximal and anterior translation of the tibial tubercle reduces PF joint pressure, allowing the procedure to be applied in patients with PF osteoarthritis and patella baja. In addition, HCWHTO is suitable for cases with severe varus deformity, flexion contracture up to approximately 15 degrees, and anterior cruciate ligament (ACL) dysfunction.

However, achieving good outcomes requires attention to several technical points: precise preoperative planning and osteotomy to avoid undercorrection, accurate determination of the hinge point, prevention of delayed union (such as smoking cessation guidance, avoidance of excessive weight bearing until bone union is achieved, and supplemental internal fixation), proper plate positioning to avoid interference with correction, and accurate intraoperative alignment control in close cooperation with the surgical assistant-factors that have the greatest influence on improving flexion contracture and maintaining correction accuracy.

With careful surgical technique, HCWHTO allows for postoperative rehabilitation aimed at early return to daily activities. Although the procedure involves complete osteotomy of both the tibia and fibula, its three-dimensional correction makes it a broadly applicable surgical technique for various deformities and pathological conditions of the knee.

SY2-2

Distal femoral osteotomy for valgus knees



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Distal femoral osteotomy (DFO) has been performed to treat patients with valgus knees and favorable outcomes were reported. Regarding surgical techniques, medial closing wedge DFO (MCWDFO) and lateral opening wedge DFO (LOWDFO) are used. Although no significant difference in clinical outcomes was found between the two techniques, faster bone union can be expected after MCWDFO than LOWDFO. Meanwhile, one of the concerns in MCWDFO is a hinge fracture during operation. Previous biomechanical and anatomical studies have indicated lateral hinge point is the major cause of hinge fracture. Similarly, our biomechanical study using finite element model analysis has suggested that hinge point should be placed in the lateral condylar area. Further, anatomical studies have shown some characteristics of shape of distal femoral cortex. Notably, the medial cortex is shorter and more inclined compared to lateral cortex, suggesting that a careful attention is required to avoid too thick anterior flange when creating an anterior flange in biplanar MCWDFO. In this presentation, surgical techniques and tips for MCWDFO based on recent studies will be presented.

SY2-3

Indications, surgical technique, and clinical outcomes of tibial condylar valgus osteotomy (TCVO)

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[Introduction]
Tibial condylar valgus osteotomy (TCVO) is one of the surgical techniques for osteotomy around the knee that especially allows correction of intra-articular deformity. It was first reported in 1992 in Nagasaki by Goji Chiba, and is now also referred to internationally as the “Chiba osteotomy.” TCVO change the shape of tibial plateau, thereby improving articular congruency and concomitantly shifting the weight-bearing line laterally.
[Indications]
TCVO is indicated for advanced medial knee osteoarthritis (OA) with Kellgren-Lawrence grade 3 or 4, joint convergence angle (JLCA) of 5 degrees or more, and pagoda deformity of the tibial plateau. It is particularly well indicated for OA knees exhibiting varus–valgus (coronal-plane) instability; the attainable degree of angular correction depends on the severity of that instability. Whole leg weight bearing radiograph and preoperative stress radiographs are essential. With TCVO alone, alignment correction is achievable up to about 1.5× the change in JLCA determined on varus- and valgus-stress radiographs. If the mechanical lateral distal femoral angle (mLDFA) is ≥ 90° and undercorrection is anticipated, TCVO alone may be insufficient and distal femoral osteotomy (DFO) should be added.
[Surgical technique]
As in OWHTO, the patient is positioned supine with the knee in extension. A Curved incision of approximately 7-cm is made on the proximal medial tibia, and a partial release of the pes anserinus insertion and a complete release of the superficial medial collateral ligament are performed. At first, a reference pin is placed anterior-posteriorly on the medial edge of the tibial tuberosity, on a line connecting the tip of the fibula and 4 cm distal from the medial tibial plateau. Under AP fluoroscopy, a longitudinal osteotomy is executed along the reference pin using a chisel toward the lateral intercondylar eminence of the tibia. The posterior cortical osteotomy is performed under lateral fluoroscopy with the knee in the figure-of-four position, taking meticulous care to avoid neurovascular injury, thereby completing the longitudinal osteotomy. Next, a bone saw is used to cut the proximal tibia, 4 cm distal from the medial tibial plateau, toward the reference pin under AP fluoroscopy, completing the L-shaped osteotomy. The osteotomy site is opened with a bone spreader forceps until the lateral femorotibial joint become parallel under AP fluoroscopy. When congruity of the lateral femorotibial joint is achieved, the Micklicz line is verified.
If consistent with the preoperative planning, definitive fixation is performed using a locking plate. Postoperatively, after suction drain removal, early range-of-motion training is instituted. Partial weight bearing begins at 1 week and is advanced to full weight bearing as pain allows.
[Clinical outcome]
From the short term to beyond 10 years, clinical results and preservation of alignment are generally good. On the other hand, a sufficient lateral shift of Micklicz line may not be obtained by TCVO alone in the case of excessive varus knee. In such cases, the combined use of OWHTO/OWDTO and/or lateral closed wedge DFO is necessary.
[Conclusion]
TCVO is considered a useful treatment alternative to total knee arthroplasty for advanced knee osteoarthritis.

SY2-4

Next-Generation Osteotomies around the knee and Elmslie Trillat Procedure-Like OWDTO

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Historically, lateral closing-wedge high tibial osteotomy (LCW-HTO) was the standard procedure, and most candidates were older patients with advanced to end-stage knee osteoarthritis. In recent years, however, knee osteotomy has evolved toward medial opening-wedge HTO (MOWHTO) and other osteotomies around the knee, which are now widely performed not only for early-stage osteoarthritis but also in combination with cartilage and meniscal procedures. This shift has led to a younger patient population and the emergence of next-generation osteotomies around the knee.
These next-generation osteotomies around the knee aim to achieve a truly “life-long surgery” and to enable “ultra-early return to society.” Although OWHTO has demonstrated favorable long-term outcomes, reported survival rates are approximately 90% at 10 years and 70% at 15 years. OWDTO has been introduced as an alternative technique that avoids an increase in patellofemoral joint (PFJ) pressure and does not induce excessive tension on the extensor mechanism, making it more PFJ-friendly.
We previously reported that our Elmslie-Trillat–procedure-like OWDTO resulted in no complications requiring reoperation and that its mid-term outcomes were superior to those of OWHTO. On the other hand, OWDTO has been associated with disadvantages such as a higher incidence of fractures and nonunion, as well as slower postoperative rehabilitation. However, these limitations have been overcome through the development of our Elmslie-Trillat–procedure-like OWDTO, which provides high load-bearing capacity and stability around the osteotomy site, along with a next-generation OWDTO plate offering enhanced fixation strength and an easy, safe, and accurate osteotomy guide, O-guide.
Because our OWDTO technique allows immediate postoperative weightbearing, the need to select total knee arthroplasty solely due to delayed rehabilitation protocols has been eliminated, thereby expanding the indications for OWDTO.

SY2-5

Opposite Lag Screw as an Adjunct in High Tibial Osteotomy with Lateral Hinge Fracture: Improved Union and Correction Maintenance

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Purpose
Lateral hinge fracture (LHF) is a common complication of medial open-wedge high tibial osteotomy (MOWHTO), associated with an elevated risk of nonunion and loss of correction. This study investigated whether the addition of an opposite lag screw placed laterally across the hinge could reduce nonunion and improve correction maintenance.

Methods
This retrospective study included patients who underwent MOWHTO for knee osteoarthritis by a single surgeon between May 2016 and May 2023 at a single center. Exclusion criteria included concomitant anterior cruciate ligament or meniscus repair, cosmetic surgery, and follow-up less than one year. Patients were divided into screw and no-screw groups, with 1:1 case–control matching based on age (±5 years), sex, and fracture type. Radiographic outcomes included weight-bearing line (WBL) ratio, hip–knee–ankle angle, femorotibial angle, medial proximal tibial angle, posterior tibial slope angle, and union time. Correction accuracy was defined as planned (WBL 57–67%), acceptable but unplanned (50–70%), or inappropriate (<50% or >70%). Complications and reoperations were also recorded.

Results
Eighty knees were analyzed (40 screws and 40 no screws). The mean follow-up period was 31 and 53 months in the screw and no-screw groups, respectively. At the final follow-up, correction was significantly better in the screw group. Planned correction was achieved in 15 screw knees versus 4 without (P = 0.0075). Inappropriate correction was less frequent in the screw group (15 vs. 25, P = 0.026). Nonunion occurred exclusively in the no-screw group (five knees). Reoperation rates were higher in the no-screw group than that in the screw group (eight vs. five revision HTOs; and three vs. no conversions to total knee arthroplasty).

Conclusions
The addition of an opposite-lag screw is a simple and practical adjunct that reduces nonunion and enhances correction maintenance in patients with LHF following MOWHTO.

SY2-6

Hyaline-Like Cartilage Regeneration after High Tibial Osteotomy with Microfracture and BMAC in Advanced Knee Osteoarthritis: A Prospective Clinical Study

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Cartilage regeneration remains a major challenge in patients with osteoarthritic knees (OA knee). Numerous studies have demonstrated that high tibial osteotomy (HTO) can alleviate symptoms and achieve favorable long-term survivorship, with evidence suggesting that cartilage regeneration may occur following the procedure. However, the majority of regenerated cartilage is believed to be fibrocartilage, which is biomechanically and structurally inferior to native hyaline cartilage. Although a definitive correlation between cartilage regeneration and clinical outcomes has not been established, we believe that the long-term survivorship of HTO may be associated with the quality of regenerated cartilage.

To enhance both the quality and quantity of cartilage regeneration after HTO, biological augmentation may play a crucial role. In recent decades, advances in regenerative medicine—such as cell-based therapies, gene editing, and bioengineered scaffolds—have been developed to promote cartilage repair and restore joint function. Nevertheless, the high cost and logistical complexity of these approaches limit their widespread clinical application in Taiwan.

Bone marrow aspirate concentrate (BMAC) has emerged as a practical and effective regenerative strategy in recent years, with expanding clinical applications. Compared with other cell-based therapies, such as those utilizing adipose-derived or bone marrow–derived mesenchymal stem cells (MSCs), BMAC is easier to harvest and administer. In our previous study on rotator cuff repair, BMAC significantly improved patient symptoms and shoulder function. Based on these findings, we hypothesized that BMAC could also facilitate cartilage regeneration in patients undergoing HTO.

Accordingly, we conducted a clinical study involving patients with unicompartmental knee osteoarthritis. From August 2021 to May 2022, a total of 13 patients (15 knees) with Kellgren–Lawrence grade III–IV OA were enrolled. All patients underwent HTO combined with arthroscopic microfracture (MF) and BMAC augmentation. Clinical outcomes were assessed using the Knee injury and Osteoarthritis Outcome Score (KOOS) at baseline and at 3, 6, and 12 months postoperatively. At 1 year postoperatively, second-look arthroscopy was performed to evaluate cartilage regeneration using the International Cartilage Regeneration & Joint Preservation Society (ICRS) and OAS scoring systems. Biopsies of regenerated cartilage were also obtained for histological analysis, including hematoxylin–eosin (H&E) and immunohistochemical (IHC) staining to assess collagen composition.

All patients recovered well and demonstrated excellent clinical outcomes at 1 year postoperatively. The mean KOOS score improved from 44.38 preoperatively to 97.14 at 1 year postoperatively. Arthroscopic evaluation revealed that 80% (12/15) of knees exhibited firm, smooth regenerated cartilage with ICRS scores >10. Histological analysis showed that 73% (11/15) of samples demonstrated type II collagen predominance within the extracellular matrix, indicating hyaline-like cartilage regeneration.

Although the sample size of this study was small and the follow-up duration was limited, the preliminary results are promising. The combination of HTO, microfracture, and BMAC augmentation may promote hyaline-like cartilage regeneration and improve clinical outcomes in patients with advanced unicompartmental knee osteoarthritis.

PD1-1

Open wedge high tibial osteotomy combined with MMPRT repair and meniscal centralization - Indications, surgical procedure, and its limitations and challenges –

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[Background] Medial meniscus posterior root tears (MMPRTs) can result in the development of osteoarthritis. Therefore, to prevent progression to osteoarthritis, early diagnosis and early intervention of MMPRTs may be required. Once an MMPRT is suspected, magnetic resonance imaging (MRI) permits accurate early diagnosis by using some typical signs (truncation, giraffe neck, white meniscus signs and meniscal extrusion). Clinical experience suggests that symptoms such as dull pain or discomfort in the popliteal area or the calf area, which are sometimes misdiagnosed as sciatic nerve pain, may precede impending MMPRT. However, there has been no report on MRI findings as precursor indicators of the development of an MMPRT. [Purpose] We found that bone marrow edema emanating from the meniscal root on MRI scans, i.e., spreading roots sign (SRS) may indicate the preliminary stage of an MMPRT. The purpose of this study was to evaluate the efficacy of the SRS as an MMPRT-predictor. [Methods] In a retrospective study, we reviewed the chart data and MRI results of patients who had required surgery for an acute-onset MMPRT between January 2018 and December 2020. Acute onsets were defined as those for which a date of onset could be specified. Surgical intervention had been indicated with osteoarthritis or progressive cartilage defect. Surgical treatments consisted of arthroscopic root repair with meniscal centralization and high tibial osteotomy (HTO) either alone or in combination and the use of HTO. We grouped patients by whether or not they had reported the above-mentioned precursory symptoms prior to acute rupture (precursory symptom group/non-precursor group), and when possible, we examined MRI scans to identify with which events the appearance/disappearance of the SRS coincided. Sex, age, body mass index, bone mineral density, radiological parameters, and MRI signs mentioned above were compared between groups. The weight-bearing line ratio and mechanical medial proximal tibial angle were calculated from full-length anteroposterior weight-bearing radiographs of the leg. The posterior tibial slope was measured on a lateral radiograph. [Results] Data from 24 patients (precursory symptom group, n=17 [70.8 %]; non-precursor group, n=7 [29.2 %]) were included; all patients had MRI scans just after acute MMPRT and data from 5 patients included MRI scans prior to acute rupture. There were no significant differences between precursory symptom and non-precursor groups, except for the ratio of the presence of the SRS (p=0.005). The appearance of the SRS on MRI scans coincided with the onset of precursory symptoms, and its disappearance coincided with acute rupture and the appearance of other MRI signs typical of MMPRT mentioned above. [Conclusions] Our findings suggest that the SRS can be used as a unique precursory sign for MMPRT. The SRS may be a warning that an MMPRT is developing due to tensile stress of the meniscal hoop. The stress can be decreased by reducing the tension caused by the acute tear.

PD1-2

Clinical Outcomes of High Tibial Osteotomy with ACL Reconstruction in Patients with ACL Deficiency and Medial Osteoarthritis

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IntroductionIt is well known that altered gait biomechanics and elevated inflammatory cytokine levels contribute to the development of medial knee OA at a relatively young age in patients with chronic ACL deficiency compared with those with an intact ACL. In ACL-deficient knees, the surgical management of medial OA remains controversial. Available surgical options include unicompartmental knee arthroplasty (UKA) with or without ACL reconstruction (ACLR), high tibial osteotomy (HTO) with or without ACLR, and total knee arthroplasty (TKA). To date, no direct comparison of these three surgical techniques has been reported. For young and active patients with knee instability and medial knee pain, HTO with or without ACLR is a commonly selected treatment strategy. However, no consensus exists regarding the indications for adding ACLR, as the decision largely depends on surgeon-specific criteria. A better understanding of the characteristics of knee instability in ACL-deficient knees with OA and the postoperative clinical outcomes following HTO with ACLR may help guide surgical decision-making. Therefore, the purpose of this study was to investigate the characteristics of preoperative knee instability and postoperative clinical outcomes in patients who underwent HTO combined with ACLR.Methods Seventeen patients (8 males, 9 females; mean age, 48 years; mean follow-up, 2.5 years) who underwent HTO with ACLR at our institution between January 2018 and December 2024 were included. Patients with contralateral ACL injury or multiple ligament injuries were excluded. Two patients underwent open-wedge distal tibial osteotomy (OWDTO), and 15 underwent open-wedge high tibial osteotomy (OWHTO). Two revision ACLR cases were included. Bone–patellar tendon–bone (BTB) graft was used in 1 patient, and hamstring tendon grafts were used in 16 patients. All reconstructions were performed using a single-bundle technique. Under anesthesia, KT-2000 measurements, pivot-shift grades (IKDC), and posterior tibial translation/acceleration during the pivot shift evaluated using an electromagnetic measurement system were obtained at both the primary surgery and second-look arthroscopy. Graft integrity was assessed during the second-look arthroscopy. Radiographic parameters included Kellgren–Lawrence (KL) grade, % mechanical axis (%MA), posterior tibial slope (PTS), and the difference in anterior tibial translation between the affected and unaffected sides on single-leg stance lateral radiographs (ATS-SSD). Clinical outcomes were assessed using the KOOS.ResultsThe preoperative KL grades were 1/7/3/6 (grades I–IV). The preoperative mean KT-SSD was 6.5 mm (range, 3–12 mm), and pivot-shift grades were 0/6/11/0. A moderate negative correlation was observed between KT-SSD and KL grade (r = 0.53). The mean %MA improved from 28.8% preoperatively to 58.5% postoperatively. The mean PTS changed from 13.1° preoperatively to 12.5° postoperatively, with no significant difference. Although the mean ATS-SSD improved significantly from 11.3% preoperatively to 7.4% postoperatively, anterior tibial translation remained greater compared with the contralateral limb. The KT-SSD decreased from 6.5 mm preoperatively to 1.8 mm postoperatively; however, 2 of 17 cases showed residual KT-SSD > 3 mm. KOOS scores improved significantly after surgery. At second-look arthroscopy, complete graft failure was observed in one case. One patient developed a surgical site infection requiring additional surgery, and one experienced recurrent varus alignment during follow-up.DiscussionHTO combined with ACLR effectively reduced anterior tibial translation and improved knee stability and clinical outcomes in ACL-deficient knees with medial compartment OA. Despite significant improvements in alignment and instability parameters, residual anterior tibial translation persisted in some patients, and graft failure or postoperative complications occurred in a minority.

PD1-3

Additional Cartilage Repair Strategies in Around-the-Knee Osteotomy: From Indications to Clinical Outcomes

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Background: Cartilage repair for focal knee lesions in athletes—autologous chondrocyte implantation (ACI) or osteochondral autograft transfer (OAT)—has demonstrated excellent outcomes, and our center has similarly achieved favorable results. Around-the-knee osteotomy (AKO) alone often provides substantial improvement in pain and function by correcting malalignment and unloading the degenerated compartment. However, residual cartilage damage or biomechanical incongruity may limit functional recovery in selected patients. In this context, the optimal indication for adding cartilage repair remains unclear. The present study reviewed a consecutive series of AKO cases to identify when adjunct cartilage repair adds value, which compartments should be prioritized, and which surgical techniques yield the most consistent clinical benefit.

Materials and Methods: We retrospectively analyzed consecutive AKO procedures, with or without concomitant cartilage repair, performed for symptomatic osteoarthritis or focal chondral defects. Lesions were categorized as involving the lateral femoral condyle (LFC), patellofemoral joint (PF; particularly the femoral trochlear and the patellar facet), or medial femoral condyle (MFC). Cartilage restoration was achieved by OAT or ACI depending on lesion size, accessibility, and tissue quality. Clinical outcomes included patient-reported outcome measures (PROMs), radiographic assessment of alignment correction, and cartilage repair quality graded using the International Cartilage Repair Society Cartilage Repair Assessment (ICRS-CRA) when available. A prespecified subgroup analysis focused on varus knees treated with AKO despite focal defects in the lateral compartment.

Results: The condition of the PF cartilage—particularly the femoral trochlear—emerged as a major determinant of PROMs. Adjunctive repair of the femoral trochlear cartilage showed a high likelihood of improving clinical outcomes, particularly in patients with anterior knee pain or patellar maltracking. Patellar facet repair was feasible only with ACI due to the limited availability of congruent osteochondral donor tissue. Femorotibial lesions were addressed with OAT whenever technically feasible, whereas PF lesions were repaired with either ACI or OAT. Both approaches yielded excellent structural and clinical results, including high ICRS-CRA grades, with low complication rates and consistent graft integration. In varus knees undergoing AKO despite focal lateral compartment defects, OAT to the LFC effectively restored joint congruity and delayed progression of lateral compartment degeneration. When combining cartilage repair with AKO, our practical priority sequence was LFC → Femoral Trochlear (and patella if feasible) → MFC (when operative time and graft availability allowed). The combined strategy achieved stable alignment correction, durable pain relief, and early functional recovery, facilitating return to recreational sports in motivated patients.

Conclusion: An algorithmic approach integrating AKO with selective, compartment-specific cartilage restoration can optimize both biomechanical correction and biological repair. Based on our experience, LFC and Femoral Trochlear lesions should be prioritized when cartilage repair is combined with AKO, as their restoration contributes most strongly to functional improvement and long-term joint preservation. Patellar facet defects require ACI for durable results, while OAT remains the method of choice for focal femorotibial defects, including those of the LFC even in varus knees. These findings suggest that combining precise realignment with targeted cartilage restoration can expand the indications for AKO beyond mechanical correction alone, achieving superior outcomes in pain relief, function, and return to sport. Further prospective studies are warranted to validate these indications and refine surgical decision-making algorithms.

PD1-4

Treatment of osteoarthritic knee with high tibial osteotomy and allogeneic human umbilical cord blood–derived mesenchymal stem cells combined with hyaluronate hydrogel composite

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-Introduction/Purpose Delaying total knee arthroplasty is crucial for middle-aged patients with severe osteoarthritis. The long-term outcomes of high tibial osteotomy (HTO) remain uncertain. Recently, mesenchymal stem cells (MSCs) have shown promising potential in enhancing cartilage regeneration. Therefore, this study aimed to assess cartilage regeneration following the implantation of allogeneic human umbilical cord blood–derived mesenchymal stem cells (hUCB-MSCs) with HTO.-Material and Methods In this case series, ten patients underwent hUCB-MSC implantation with HTO. The median age was 58.50 (range: 57.00–60.00) years, and the mean body mass index was 27.81 (range: 24.42–32.24) kg/m2. Clinical outcomes, including the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), visual analog scale (VAS), Physical Component Score (PCS) and Mental Component Score (MCS) from the 36-Item Short-Form Health Survey (SF-36), were evaluated 6 months, 1 year, and 2 years postoperatively. Cartilage status of the medial femoral condyle (MFC) was assessed during hardware removal surgery, at least 2 years after the initial procedure, and compared with preoperative MFC cartilage status regarding lesion size and International Cartilage Repair Society (ICRS) grade. Radiological assessments included the Kellgren–Lawrence (KL) grading system for medial compartment osteoarthritis and hip–knee–ankle (HKA) angle.-ResultsSignificant improvements were observed in WOMAC scores (preoperative: 57.00 (range: 44.75–63.00), postoperative: 27.50 (range: 22.25–28.75)), VAS scores (preoperative: 66.25 (range: 48.00–74.25), postoperative: 26.25 (range: 14.50–31.13)), SF-36 PCS (preoperative: 27.97 (range: 26.64–31.25), postoperative: 55.31 (range: 51.64-62.50)), and SF-36 MCS (preoperative: 41.04 (range: 29.95–50.96), postoperative: 63.18 (range: 53.83–65.16)) 2 years postoperatively (p = 0.002, 0.002, 0.002, and 0.020, respectively). The MFC chondral lesion demonstrated significant improvement in both lesion size (preoperative: 7.00 cm² (range: 4.38–10.50 cm²), postoperative: 0.16 cm² (range: 0.00–1.75 cm²), p = 0.002) and ICRS grade (preoperative: 4 (range: 4–4), postoperative: 1 (range: 1–2.25), p = 0.002). Additionally, the KL grade significantly decreased from 3 (range: 3–3) preoperatively to 2 (range: 2–2) postoperatively, while the HKA angle was corrected from 7.50˚ (range: 7.00–10.25˚) preoperatively to -1.00˚ (range: -3.5–0.00˚) postoperatively.-ConclusionhUCB-MSC implantation with HTO is an effective treatment for medial compartment osteoarthritis and varus deformities, resulting in significant improvements in cartilage regeneration and overall clinical outcomes

PD1-5

Distal femoral osteotomy with medial patellofemoral ligament reconstruction for recurrent patellar dislocation

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Recurrent lateral patellar dislocation (RPD) is a multifactorial problem as patellar stability relies on limb alignment, the osseous structure of the patella and trochlea, and the integrity of static and dynamic soft-tissue constraints. The management of RPD is difficult for a number of reasons, including a heterogeneous patient population, a variety of technically challenging surgical techniques, and a lack of long-term and robust clinical outcome studies. RPD can be complicated by the presence of lower extremity malalignment, such as valgus deformity. This deformity has been shown to increase the quadriceps angle (Q-angle) and patellar maltracking, which results in greater lateral patellar forces. DFO is one of the methods for managing valgus deformity, which reduces the Q-angle and improves patellar tracking. It is typically not performed in isolation but is combined with soft-tissue procedures, most commonly Medial Patellofemoral Ligament (MPFL) reconstruction, for the best outcome. However, there are several technical challenges for this combined procedures. In this lecture, I will present cases with combined DFO and MPFL reconstruction and discuss with panelists.

PD1-6

Fresh Femoral Osteochondral Allograft Transplantation Using a Single-Plug Technique for Large Osteochondral Defects of the Knee

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Osteochondral allograft (OCA) transplantation has been used to treat a wide spectrum of cartilage deficiencies in the knee, including spontaneous necrosis of the knee. Studies reporting outcomes after OCA transplantation have shown reliable improvement in pain and return to activities of daily living. We describe a single-plug, press-fit technique for OCA transplantation with concomitant high tibial osteotomy to treat femoral condyle chondral defects in a varus knee. Pearls and pitfalls of this technique are presented; attention should be paid to correction of concomitant joint pathology and malalignment to facilitate osseointegration and survivorship of the allograft plug into host bone. Appropriate surgical timing and prompt allograft implantation help to maximize chondrocyte viability.

PD2-1

Knee extensor strength in knee osteotomy, particularly open-wedge high tibial osteotomy

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Around knee osteotomy (AKO) including open-wedge high tibial osteotomy (OWHTO) and distal tibial osteotomy (OWDTO) is widely performed to treat patients with medial compartmental knee osteoarthritis (OA) and previous studies have reported favorable outcomes including return to sports and patient-reported satisfaction. Although these reports have indicated that patient background and surgical strategy could affect patient-reported outcomes, the influence of postoperative rehabilitation on the outcomes is poorly investigated. Postoperative rehabilitation is performed to reduce pain and improve joint range of motion and knee muscle strength. In particular, knee extensor strength is one of critical factors affecting physical function in patients with knee OA and those after total knee arthroplasty. However, there are few reports on the recovery of knee extension strength in AKO or the impact of knee extension strength on postoperative outcomes. We investigated the recovery of knee extensor strength after OWHTO and OWDTO. The results showed that knee extensor strength on involved limb was significantly improved from preoperative to 12 months after OWHTO (preoperative: 0.82 ± 0.39 Nm/kg, at 12 months: 1.11 ± 0.38 Nm/kg, $p = 0.012$). In patients after OWDTO, knee extensor strength on involved limb was also improved at 12 months but not significant (preoperative: 0.85 ± 0.44 Nm/kg, at 12 months: 1.12 ± 0.44 Nm/kg, $p = 0.078$). This result indicated that difference of surgical procedures can affect the recovery of knee extensor strength after AKO (Goto R, Matsushita T, Ueda Y, et al. Knee. 2024). We also investigated the association between knee extensor strength on involved limb and patient-reported outcomes measured by International Knee Documentation Committee (IKDC) subjective score. In conclusion, knee extensor strength normalized to body weight was significantly associated with IKDC subjective score at 12 months after OWHTO, after adjusted covariates including age, sex, body mass index, OA grade, and radiographic parameters ($\beta = 0.40$, $p = 0.02$). This result suggested that the recovery of knee extensor strength is important for improving patient-reported outcome after OWHTO (Ueda Y, Matsushita T et al. in review). In this panel discussion, we will discuss the importance of knee extension strength in AKO.

PD2-2

Evaluation of Functional Recovery for Safe Return to Sports Following Knee Osteotomy

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Around knee osteotomy (AKO) is an effective treatment for knee osteoarthritis and is widely performed in relatively young, active patients. The primary purpose of AKO is to correct knee joint alignment, reduce pain, and improve function. However, recent patient treatment goals have expanded beyond merely regaining activities of daily living to include returning to sports and maintaining high levels of physical activity after surgery.
Therefore, postoperative rehabilitation is now expected to support the recovery of higher-level functional abilities. According to existing reports, the return-to-sport rate after AKO is approximately 80%, but the rate for high-impact sports remains low. Therefore, establishing safe and effective return-to-sport criteria is a critical clinical challenge.
To support a safe return to sports after AKO, our institution designates achieving jogging at 3 months postoperatively as a primary rehabilitation goal. This goal enhances patient psychological motivation while also serving as a useful objective indicator for evaluating postoperative physical function recovery. Consequently, we are conducting a clinical study that includes continuous functional assessment from the preoperative to postoperative period to examine factors related to jogging acquisition and return to sports.
Rehabilitation assessment is conducted preoperatively, and at 3 weeks, 6 weeks, 3 months, 6 months, and 12 months postoperatively. Lower limb muscle strength assessment measures knee flexion/extension, hip extension/abduction/adduction, and ankle plantar flexion to evaluate overall lower limb strength balance. Functional movement assessments begin at 3 months post-surgery. Eligible cases include those with satisfactory bone union and physician approval for single-leg weight-bearing, provided there are no issues such as knee joint swelling and the lower limb muscle strength LSI (Limb Symmetry Index) is 70% or greater. The program includes single-leg standing (40 cm off the floor), single-leg squats, and jogging (starting at 6 km/h with gradual speed increases). Six months post-surgery, jumping movements (landing, vertical jump, drop jump) are added. In addition, sport-specific movements are also gradually introduced based on patient needs. These evaluations aim not only to confirm the acquisition of movement but also to assess performance quality.
Furthermore, each movement assessment utilizes AI analysis of videos captured in the sagittal and frontal planes to objectively evaluate whole-body joint alignment. For example, we quantitatively confirmed factors such as knee varus/valgus during single-leg landing, bilateral differences in knee flexion angle, compensatory movements in the hip or ankle joints, and the presence of trunk lateral flexion. This data is accumulated as reproducible information.
Our clinical data showed a jogging acquisition rate of 90% at 3 months and 97% at 6 months post-surgery. The present study included 39 patients who underwent OWDTO or OWHTO, with an average age of 49.6 years and a preoperative Tegner Activity Scale (TAS) score of 5 or greater. Analysis of the group that achieved jogging within 3 months showed that hip extensor muscle strength was the strongest associated factor. This result suggests that preoperative muscle training focused on hip extensors and education/management of exercise habits is crucial for a safe return to sports after AKO.
Therefore, continuous functional assessment and AI-based motion analysis after AKO are useful for establishing objective criteria for a return to sport. Further accumulation of cases and long-term follow-up are expected to enable the development of more refined return protocols. Additionally, a comprehensive management system incorporating preoperative educational interventions and the establishment of exercise habits is considered to enhance patient safety and satisfaction, leading to improved sports return rates.

PD2-3

Latest Rehabilitation Strategies for Patients Undergoing Open-Wedge High Tibial Osteotomy Using the MyMobility Smartphone Application for Patient Education and Exercise Guidance

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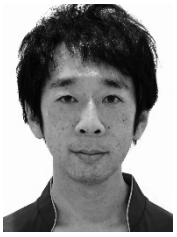
Open-wedge high tibial osteotomy (OWHTO) is a joint-preserving procedure for medial compartment knee osteoarthritis, applicable to young and elderly patients desiring early return to work or sport. Early recovery mandates progressive activity; however, severe postoperative pain or pain catastrophizing extends rehabilitation. Inadequate patient education may lead to excessive rest, prolonging recovery. Smartphone applications such as MyMobility (Zimmer Biomet, IN, USA) provide step-count monitoring, patient education through chat, and video-guided exercises, promoting safe activity progression. Previous studies in total hip and knee arthroplasty demonstrate that MyMobility enhances activity levels, correlating with improved outcomes. Its role in OWHTO remains unexamined. Postoperative OWHTO rehabilitation necessitates staged weight-bearing to avert hinge fractures, typically delaying functional recovery by approximately 6 months. This report details two elderly cases at risk of protracted recovery, in which MyMobility use prevented prolonged postoperative rehabilitation. The first is an 83-year-old male with severe preoperative pain and pain catastrophizing; he achieved functional recovery within 3 months. The second is a 71-year-old female; despite advanced age, she resumed running within 6 months. At this symposium, we will present the specific rehabilitation protocols of these two cases, illustrating MyMobility's efficacy in mitigating anticipated delays and expediting recovery in OWHTO patients.

PD2-4

Efforts to Improve High Tibial Osteotomy Outcomes Through an Interprofessional Collaboration-Based Weight Management Program



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【Background】High tibial osteotomy (HTO) is an established joint-preserving procedure for medial compartment knee osteoarthritis. Postoperative outcomes depend on multiple factors, including deformity severity, correction angle, loss of correction, and obesity. Obesity is associated with loss of correction, worsening patient-reported outcomes, and reduced implant survival in the medium to long term. Although interprofessional collaboration (IPC) is considered effective for weight management, systematic evidence for structured weight management programs in HTO patients remains limited, and the impact of postoperative weight gain on clinical outcomes has not been fully clarified.【Purpose】
This study aimed to evaluate the effectiveness of an IPC-based weight management program in HTO patients with a preoperative BMI ≥25. Secondary objectives were to clarify the impact of postoperative weight gain on clinical outcomes, identify independent predictors of ≥5% postoperative weight gain, and determine a cutoff value for early identification of high-risk patients requiring intensive weight management support.【Methods】An interprofessional team comprising orthopedic surgeons, nurses, registered dietitians, and physical therapists was established to deliver a standardized weight management program. The IPC group (n=117; mean age 68.8±8.4 years; BMI 24.4±3.4 kg/m²) received structured interventions based on a dedicated HTO patient pamphlet, targeting ≥5% weight loss for patients with BMI ≥25 and weight maintenance for those with BMI <25. The non-IPC control group (n=134; mean age 68.7±9.1 years; BMI 24.9±4.0 kg/m²) received routine care without systematic weight management protocols. Among 258 patients with complete 24 month follow-up data, the association between postoperative weight change and clinical outcomes was analyzed using logistic regression. Weight change was categorized with –3% to +3% as the reference group. Outcomes included %MA ≥62%, isometric knee extension strength, and KOOS subscales (Symptoms, Pain, ADL, Sport/Recreation, Quality of Life). For factors significantly associated with postoperative weight gain ≥5%, cutoff values were determined by receiver operating characteristic (ROC) curve analysis.【Results】The IPC program achieved significantly higher rates of ≥5% weight loss at 12 months compared with non-IPC care (odds ratio [OR] 3.190, 95% confidence interval [CI] 1.060–9.560). Patients with postoperative weight gain ≥5% showed worse outcomes in multiple domains: KOOS Sport/Recreation (OR 0.296, 95% CI 0.120–0.729), KOOS Quality of Life (OR 0.446, 95% CI 0.187–0.960), and isometric knee extension strength (OR 0.113, 95% CI 0.013–0.954). Preoperative isometric knee extension strength (cutoff 0.87 Nm/kg; area under the curve [AUC] 0.608) and 3 month postoperative weight change rate (cutoff 1.80%; AUC 0.726) were identified as independent predictive factors for weight gain ≥5% at 24 months.【Conclusion】These findings demonstrate the effectiveness of IPC-based weight management for patients with preoperative BMI ≥25 and underscore the importance of preventing postoperative weight gain in HTO patients. The identified predictive factors provide practical tools for early identification and targeted intervention in high-risk populations.

PD2-5

Multi-Segment Biomechanical Analysis After High Tibial Osteotomy and Distal Tuberosity Tibial Osteotomy

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Around knee osteotomies, including High Tibial Osteotomy (HTO) and Distal Tuberosity Tibial Osteotomy (DTO), are widely used to correct lower-limb malalignment in patients with knee osteoarthritis. Although these procedures are primarily intended to realign the mechanical axis and redistribute load within the knee joint, the resulting changes can also affect motion patterns at the hip, ankle, and subtalar joint (STJ). Clinical observations have indicated that these adjacent joints may undergo meaningful biomechanical adaptation, yet the specific relationships remain insufficiently characterized. A more comprehensive understanding of multi-segment interactions may therefore support more refined perioperative decision-making.

We previously showed that the Hip-to-calcaneus line (HCL)—the line between the hip center and the inferior calcaneal border—demonstrates a stronger association with postoperative clinical outcomes compared with the conventional Mikulicz line ($p < 0.05$). Because the HCL reflects hindfoot mobility, deviations in this parameter may provide additional context regarding STJ behavior following osteotomy. In this study, subtalar kinematics and lateral knee acceleration before and after HTO/DTO were quantified using an electronic goniometer and lower-limb accelerometers. Preoperative excessive subtalar pronation tended to improve after surgery; however, postoperative increases in pronation were more frequently observed in patients whose medial proximal tibial angle (MPTA) reached 93° or greater. This finding suggests that overcorrection may influence hindfoot alignment, even when the intended knee alignment has been achieved. A significant correlation was identified between postoperative lateral knee acceleration and STJ motion ($r = 0.42$). This relationship indicates that subtalar pronation–supination mechanics contribute to postoperative knee kinematics during gait, highlighting the relevance of distal joint behavior in understanding functional recovery. Additional analyses focused on patients whose postoperative %mechanical axis remained below 60%. A leaf-spring insole was applied to modify foot loading. While STJ motion did not change significantly, lateral knee acceleration was reduced ($p < 0.01$), suggesting that foot-level interventions can modulate dynamic knee loading independently of subtalar mechanics.

Hip morphology was also evaluated. Acetabular roof obliquity (ARO) was associated with loss of correction after both HTO and DTO, indicating that proximal anatomical factors may affect alignment stability. Proximal kinematics measured using inertial sensors revealed that a larger contralateral pelvic drop during stance was associated with higher lateral knee acceleration, suggesting that pelvic motion may also contribute to dynamic knee behavior after osteotomy. These observations have prompted the development of a pelvic-tilt control device aimed at limiting excessive pelvic drop. Future work will explore whether stabilizing pelvic motion or improving hip muscle function can beneficially influence postoperative knee dynamics.

Overall, this study offers a multi-segment assessment of lower-limb biomechanics following HTO and DTO, integrating knee kinematics, subtalar behavior, hip morphology, pelvic motion, and foot-based interventions. The findings provide a biomechanical context that may help inform postoperative management and individualized rehabilitation strategies.

OS1-1

Hybrid Lateral Closed-Wedge High Tibial Osteotomy Showed Similar Accuracy in Angular Correction and Reduction of Posterior Tibial Slope Compared to Opening-Wedge High Tibial Osteotomy: A Correction Angle Matched Cohort Study

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Background: We aimed to compare the accuracy of applied correction angle between hybrid lateral closed wedge high tibial osteotomy (hybrid HTO) and medial open wedge high tibial osteotomy (OWHTO), and verify previous reports on hybrid HTO by matching correction angle between groups. Change in various radiological parameters including union rate were also compared.
Methods: A total of 50 OWHTO patients were selected for 2:1 propensity matching with 25 hybrid HTO patients. Rate of correction error was calculated by dividing the difference between the change in medial proximal tibial angle and preoperatively planned correction angle (PRD) by planned correction angle. Accuracy of angular correction was assessed using PRD and correction error rates. Hip-knee-ankle axis, mechanical lateral distal femoral angle, medial proximal tibial angle, joint line convergence angle, and length of the entire lower limb and tibiawere measured. The Caton-Deschamps index (CDI)was used to assess change in patellar height. Serial postoperative radiographic analysis was performed to assess the union rate.
Results: The discrepancy between planned correction angle and real correction angle was 0.8 ± 2.3˚ in hybrid HTO and 1.1 ± 3.4˚ in OWHTO (P > .05), and the rate of error in osteotomy was similar between the groups approximately 6%. Postoperatively, posterior tibial slope (PTS) (P < .001), tibia length, and CDI (P < .001) were significantly different between groups. The amount of change in PTS (P < .001), tibia length in hybrid HTO (P < .001), and CDI (P < .001) were significantly different between groups. Union rate of osteotomy site was significantly faster in hybrid HTO than in OWHTO (P < .001).
Conclusion: Hybrid HTO showed similar accuracy in angular correction compared to correction angle-matched OWHTO. Reduction in PTS, tibial shortening, maintained patellar height relative to the proximal tibia, and faster osteotomy site union were also confirmed in hybrid HTO.

OS1-2

Differences in Patellofemoral Alignment and Proximal Tibiofibular Joint Changes Between Open Wedge Distal Tibial Osteotomy and Closed Wedge High Tibial Osteotomy for Medial Knee Osteoarthritis

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-Introduction/Purpose: Open-wedge distal tuberosity osteotomy (OWDTO) and closed-wedge high tibial osteotomy (CWHTO) are both suitable procedures for treating medial compartment knee osteoarthritis with concomitant patella femoral joint degeneration. However, only a few studies have compared these two techniques. The purpose of this study was to compare the effects of CWHTO and OWDTO on lower-limb alignment, patellar morphology, and clinical outcomes in patients requiring large corrections.
-Material and Methods: This study included 37 patients who underwent CWHTO and 45 patients who underwent OWDTO between 2018 and 2023, each requiring a correction of 9.0° or more. The evaluated parameters were medial proximal tibial angle (MPTA), % mechanical axis (%MA), fibular head height (FHH), posterior tibial slope (PTS), Insall–Salvati Index (ISI), Caton–Deschamps Index (CDI), patellar tilt (PT), and patellar lateral shift (PLS), as well as clinical outcomes, including the Japan Knee Osteoarthritis Measure (JKOM) and the Knee Injury and Osteoarthritis Outcome Score (KOOS). The change between preoperative and one-year postoperative values was defined as Δ. Statistical analysis was performed using the Mann–Whitney U test.
-Results: There were no significant differences in the mean correction angle between the two groups (CW group: 10.8° vs OW group: 10.0°, p = 0.27).
Regarding lower-limb alignment, no significant differences were observed in ΔMPTA (5.0 ± 3.8° vs 5.1 ± 3.8°, p = 0.13) or Δ%MA (40.5 ± 4.2% vs 30.1 ± 16.1%, p = 0.09). However, ΔFHH (2.7 ± 5.3 mm vs 0.4 ± 1.1 mm, p < 0.01) and ΔPTS (-2.9 ± 3.7° vs 0.8 ± 2.1°, p < 0.01) were significantly greater in the CW group. Regarding patellofemoral parameters, there were no significant differences in ΔISI (0.02 ± 0.1 vs -0.01 ± 0.02, p = 0.50) or ΔCDI (0.01 ± 0.04 vs -0.05 ± 0.03, p = 0.65), whereas ΔPT (-1.8 ± 0.5° vs 2.8 ± 1.3°, p < 0.01) and ΔPLS (-1.6 ± 1.3 mm vs 3.9 ± 1.2 mm, p < 0.01) were significantly smaller in the CW group. In terms of clinical outcomes, only the change in JKOM score for pain and stiffness was significantly greater in the CW group (10.5 ± 6.4 vs 7.2 ± 5.4, p = 0.02).
-Conclusion: This study suggested that there was no difference in patellar height between the two groups. However, OWDTO was associated with greater lateral patellar tilt, while CWHTO had a more pronounced effect on posterior tibial slope and the proximal tibiofibular (PTF) joint. Surgeons should consider patellar tilt, posterior tibial slope, and the PTF joint when selecting the appropriate procedure.

OS1-3

Clinical outcomes of hybrid lateral closed wedge high tibial osteotomy in medial osteoarthritic knees with ACL insufficiency

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-Introduction/Purpose
High tibial osteotomy (HTO) is a treatment option for patients with medial compartmental knee osteoarthritis (OA) secondary to anterior cruciate ligament (ACL) insufficiency. In ACL-insufficient varus knees, correction in both the coronal and sagittal planes is important for restoring proper alignment and stability. Hybrid closed wedge high tibial osteotomy (HCWHTO) is a technique that can correct alignment in both planes. However, there is limited information about its effectiveness for medial OA associated with ACL insufficiency. Therefore, this study aimed to evaluate radiographic and clinical outcomes following HCWHTO in ACL-insufficient knees.
-Materials and Methods
This retrospective study was composed of 11 knees (mean age 47.8±9.5 years) who underwent HCWHTO between 2018 and 2022 for medial OA with ACL insufficiency. Radiographic assessments included hip-knee-ankle (HKA) angle, posterior tibial slope (PTS), anterior tibial subluxation (ATS), and anterior instability measured by KT-1000 knee arthrometer. Clinical outcomes were assessed using the Knee injury and Osteoarthritis Outcome Score (KOOS). All parameters were assessed preoperative and 2 years postoperative evaluations.
-Results
The total KOOS improved from 321.7 preoperatively to 371.4 postoperatively. The HKA angle changed from 6.8° varus to 3.7° valgus. PTS decreased from 12.3° to 8.1° postoperatively. ATS decreased from 11.6mm to 8.9mm postoperatively. The side-to-side difference in KT-1000 measurements decreased from 1.5 mm to 0.3 mm postoperatively. No patient required additional ACL reconstruction during follow-up.
-Conclusions
This study demonstrated that HCWHTO for varus osteoarthritic knees with ACL insufficiency allows correction in both the coronal and sagittal planes. By reducing the posterior tibial slope, this procedure also improved ligamentous stability. Therefore, HCWHTO may serve as a useful surgical option for managing varus knee osteoarthritis with concomitant ACL insufficiency.

OS1-4

Return to Sports after Inverted V-Shaped High Tibial Osteotomy for Severe Medial Knee Osteoarthritis: Comparison with Medial Opening Wedge High Tibial Osteotomy

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-Introduction/Purpose: High tibial osteotomy (HTO) is increasingly performed in physically active patients with medial knee osteoarthritis (OA), who often have high expectations for return to sports (RTS). While several studies have reported on RTS following medial opening wedge HTO (OW-HTO), there is limited information regarding RTS after closing or neutral wedge (NW) HTO. We have originally developed an inverted V-shaped HTO (IV-HTO) for severe varus deformity, which is classified as a NW osteotomy. However, there were no reports on the details of RTS following IV-HTO. The purpose of this study was to compare RTS rates and clinical outcomes following the IV-HTO procedure with those after OW-HTO.
-Material and Methods: A total of 367 patients who underwent HTO for a medial OA from January 2017 to December 2022 were enrolled retrospectively in this study. Of those, 107 patients participated in sports activity before surgery. HTO was performed using the inverted V-shaped-HTO procedure (IV group) or OW-HTO procedure (OW group), according to the following indications. The indication of the IV-HTO included (1) a knee in which a valgus correction of more than 10° was needed to change the mechanical axis of the lower limb to 65%, or (2) a knee having patellofemoral (PF)-OA of stage 2 (the Kellgren-Lawrence classification) or more. The indication of the OW-HTO involved (1) a knee in which a valgus correction of 10° or less was enough to change the mechanical axis to 65%, and (2) a knee having PF-OA of stage 0, 1 or 2. In the IV group, 54 patients underwent inverted V-shaped-HTO. In the OW group, 53 patients underwent OW-HTO. We evaluated the pre-symptomatic, preoperative, and postoperative Tegner activity scale (TAS), clinical outcome, and radiographic parameters before and 2 years after surgery. Statistical analyses were made using the paired t test and Mann-Whitney U test. The significant level was set at $p=0.05$.
-Results: The IV group had significantly higher preoperative OA grades at the FT (femorotibial) and PF joints than the OW group (both $p<0.01$ at the FT and PF joints, respectively). At 2 years postoperatively, 49 out of 54 patients (90.7%) in the IV group and 48 out of 53 patients (90.6%) in the OW group returned to sports. There were no significant differences in the RTS rates between the groups. The time to RTS after HTO averaged 8.4 months and 8.7 months in the IV and OW groups, respectively, with no significant difference between the groups. The pre-symptomatic, preoperative, and postoperative TAS averaged 4.8 (range: 3-7), 2.8 (0-5), and 4.3 (3-7) in the IV group, and 5.0 (range: 3-7), 3.2 (1-4), and 4.6 (3-7) in the OW group, respectively. The postoperative TAS was significantly higher than the preoperative values in both groups ($p<0.01$). However, 17 patients in the IV group (34.7%) and 17 patients in the OW group (35.4%) did not recover to their pre-symptomatic TAS postoperatively at 2 years. The functional knee score (Japanese Orthopaedic Association score), and Lysholm score significantly improved after both types of HTO surgery compared to preoperative values ($p<0.01$). Regarding preoperative coronal lower leg alignment, the IV group had severe varus deformity. There were no significant differences in the postoperative coronal alignment between the groups.
-Conclusion: Although the preoperative degrees of varus knee, FT and PF-OA were more severe in the IV group than the OW group, the RTS rates of the patients who underwent IV-HTO were comparable than those who underwent OW-HTO. Therefore, when the patients who wish to RTS have severe varus knees combined PF and FT OA preoperatively, an inverted V-shaped HTO procedure may be one of the surgical options.

OS2-1

Equivalent Correction Requirements but Different Limb-Length Effects Between OWHTO and HBHTO: Analysis of 99 Virtual Simulations

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-Introduction/Purpose
Medial open-wedge high tibial osteotomy (OWHTO) and hybrid lateral closed-wedge high tibial osteotomy (HBHTO) are based on different geometric principles, yet the influence of starting-point depth and hinge position on correction behavior has been insufficiently investigated. This study compared virtual OWHTO and HBHTO models to evaluate whether these geometric variations affect correction outcomes.
-Material and Methods
Long-leg standing radiographs from 99 patients who underwent osteotomy between 2016 and 2024 were used to generate virtual osteotomy simulations. All models were standardized to achieve the Fujisawa point. Four configurations were applied identically: OWHTO with starting points 30 mm and 40 mm below the joint line (OW30, OW40), and HBHTO with hinge ratios of 1:2 and 1:3 (HB12, HB13).
Pre-simulation HKA (hip–knee–ankle) angle, pre-simulation MPTA (medial proximal tibial angle), pre-simulation limb length, simulated correction angle, post-simulation MPTA, post-simulation HKA angle, post-simulation limb length, and simulated limb-length change were recorded.
-Results
Required correction angles and post-simulation MPTA values were similar across the four osteotomy configurations. Limb-length change differed distinctly between techniques: OWHTO resulted in lengthening (+6.8 mm), whereas HBHTO produced slight shortening (–1.4 mm). Linear regression demonstrated that correction angle was strongly associated with limb-length change in OWHTO (OW40: $\beta = 0.99$, $p < 0.001$; OW30: $\beta = 0.98$, $p < 0.001$), whereas no significant association was observed in HBHTO.
-Conclusion
The correction angle required to achieve the target alignment did not differ among the four osteotomy methods. However, limb-length change differed markedly between OWHTO and HBHTO, indicating that this factor should be taken into account when planning osteotomies involving larger corrections.

OS2-2

Anterior Closing-Wedge Osteotomy (ACWO) for Revision ACL Reconstruction FMidterm Outcomes in Four Cases

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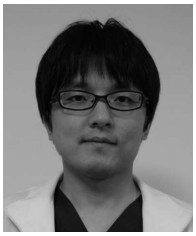
-Introduction/Purpose
Revision anterior cruciate ligament (ACL) reconstruction can be technically demanding and biologically challenging, particularly in patients presenting with a steep posterior tibial slope (PTS). Excessive PTS increases anterior tibial translation and graft strain under load, predisposing to graft elongation and failure. Slope correction through anterior closing-wedge osteotomy (ACWO) has been proposed as an effective technique to restore sagittal alignment and reduce anterior shear forces on the graft.
At our institution, the indication for ACWO includes revision ACL reconstruction in patients with PTS exceeding 12 degrees. This combined strategy aims to correct sagittal malalignment, reduce graft stress, and improve overall knee stability. The purpose of this study was to report the midterm clinical and radiographic outcomes of four patients who underwent revision ACL reconstruction combined with sub-tuberosity ACWO, focusing on postoperative knee instability, functional recovery, and procedural safety.
-Material and Methods
Four patients (mean age, 25.5 years; range, 17–41 years) underwent revision ACL reconstruction combined with sub-tuberosity ACWO between 2021 and 2023. Two patients underwent a second revision, while the remaining two underwent a first revision. The target correction angle was set at 8–10°. In all cases, the osteotomy was performed below the tibial tubercle. Fixation was achieved using a locking plate until complete bony union was confirmed radiographically. Anterolateral ligament reconstruction (ALLR) was performed concurrently in all cases to enhance rotational stability. Clinical evaluations included the KT-1000 side-to-side difference, patient-reported outcome measures (PROMs) such as Lysholm score and Knee injury and Osteoarthritis Outcome Score (KOOS), and PTS measurements obtained from pre- and postoperative lateral radiographs.
-Results
The mean follow-up period was 1.8 years (range, 1.5–2.0 years). KT-1000 side-to-side difference improved to 1–2 mm in all cases. Lysholm score and KOOS demonstrated excellent recovery, with a mean Lysholm score of 96.5 (range, 86–100) and a mean KOOS of 94.9 (range, 82.7–100) at the final follow-up. PTS was successfully reduced from 14.2°–16.0° preoperatively to 3.1°–6.7° postoperatively, and the correction was maintained in all patients. Radiographic assessment confirmed solid bony union in every case without loss of correction or implant-related complications. No graft re-rupture, infection, or hardware irritation occurred.
-Conclusion
In revision ACL reconstruction for patients with excessive PTS (≧12°), sub-tuberosity ACWO effectively restores sagittal alignment and improves knee stability. This combined approach yielded excellent short- to mid-term clinical outcomes, with consistent improvements in objective stability and patient-reported function. Our findings suggest that ACWO represents a valuable adjunctive technique for preventing recurrent graft failure in complex ACL revision surgery.

OS2-3



Characterizing Japanese valgus knees and simulation of around the knee osteotomy

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Introduction/Purpose
This study sought to delineate the morphological characteristics of valgus knees in a Japanese cohort, with particular emphasis on the center of deformity, and to estimate the appropriate proportion and type of around-the-knee osteotomy (AKO) that would be indicated based on these patterns.
Material and Methods
Between 2020 and 2024, 700 patients (1,400 knees) were randomly sampled from all individuals who received full-length, weight-bearing lower-limb radiographs at a single institution. After exclusions for weight-bearing line ratio (WBLR) <50%, Kellgren–Lawrence (KL) grade 4, or severe deformities or prior surgery outside the knee, 118 knees (8.4%) remained eligible. Radiographic parameters were measured using mediCAD®, and the coronal plane alignment of the knee (CPAK) classification was assigned. The center of deformity was localized (femur, tibia, both neutral), and AKO simulations were performed accordingly, including medial closed-wedge distal femoral osteotomy (mCWDFO), medial closed-wedge high tibial osteotomy (mCWHTO), and double-level osteotomy (DLO).
Results
A total of 118 knees were analyzed (mean age 63.5 ± 16.0 years; 89 females, 75.4%). KL grade 0 was most common (63 knees, 53.4%). By CPAK, type III predominated (66 knees, 55.9%), followed by type II (38 knees, 32.2%). Mean alignment values were: hip–knee–ankle (HKA) angle 2.9 ± 2.7°, medial proximal tibial angle (MPTA) 88.0 ± 2.0°, and mechanical lateral distal femoral angle (mLDFA) 85.0 ± 2.1°. With respect to deformity localization, neutral alignment of both femur and tibia was most frequent (48 knees, 40.7%), while isolated femoral-based valgus was nearly as common (47 knees, 39.8%), and isolated tibial-based valgus occurred less often (16 knees, 13.6%). In simulation, medial closed-wedge distal femoral osteotomy (mCWDFO) was most frequently indicated (64 knees, 54.2%), followed by medial closed-wedge high tibial osteotomy (mCWHTO) (26 knees, 22.0%) and double-level osteotomy (DLO) (17 knees, 14.4%).
Conclusion
In Japanese valgus knees, absence of a discrete deformity center was most common, with femoral-based deformity occurring at a nearly identical frequency and tibial-based deformity less frequently. Correspondingly, DFO emerged as the leading simulated AKO. This distribution contrasts with prior reports from German cohorts, where tibial-based deformity and HTO predominate. These findings highlight population-specific differences in valgus knee morphology and reinforce the need for preoperative planning tailored to the demographic under study, particularly when selecting between femoral-, tibial-, and double-level correction strategies.

OS2-4

The Effect of Hybrid Closed Wedge High Tibial Osteotomy on Joint Line Convergence Angle

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Introduction
The Joint Line Convergence Angle (JLCA) reflects soft tissue laxity and its variations post High Tibial Osteotomy (HTO) can significantly influence the lower limb alignment, potentially leading to corrective errors. Therefore, JLCA is considered a crucial parameter in the preoperative planning of HTO. The purpose of this study is to clarify the effect of Hybrid Closed Wedge High Tibial Osteotomy (HCWHTO) on JLCA.
Methods
A total of 37 patients who underwent HCWHTO from January 2023 to December 2023 were included in this study. There were 14 male and 23 female with a mean age of 61.6 years at the time of surgery. The mean follow-up period was 18.3 months. The diagnosis of all patients was osteoarthritis (OA) of the knee, classified as Kellgren-Lawrence (KL) Grade II in 19 cases, Grade III in 12, and Grade IV in 6. The surgical procedure involved setting a target percentage of mechanical alignment (%MA) at 65%, followed by fibular osteotomy, exposure of the proximal tibia, tibial osteotomy and fixation using a lateral proximal. Postoperative rehabilitation commenced the day after surgery, including range of motion exercises, muscle training around the knee. We permitted partial weight-bearing walking after one week, and full weight-bearing walking after two weeks. Each patient underwent radiographic evaluations immediately and 1 year after surgery. We radiographically measured JLCA through standing, supine, and Rosenberg views, %MA, femorotibial angle (FTA), medial proximal tibial angle (MPTA), mechanical lateral distal femoral angle (mLDFA), tibial posterior slope (TPS) and Caton-Deschamps index (CDI). Statistical analyses were performed using t-tests, with a significance level set at $p = 0.05$.
Results
The mean correction angle was 12.8°at surgery. In the radiographic measurements, JLCA significantly decrease in standing from 4.8° preoperatively to 2.7° postoperatively. No significant differences were observed in JLCA during supine and Rosenberg views. Additionally, the %MA significantly improved from 11.3% preoperatively to 66.2% postoperatively, while FTA significantly changed from 181.2° to 168.6° and MPTA from 83.1° to 94.8°.
Discussion
It is known that the variation in JLCA increases with severe varus deformities and larger correction angles. A preoperative JLCA greater than 4° can lead to overcorrection post-HTO, it is very important to carefully observe changes in JLCA as a risk factor for overcorrection. In this study, the preoperative FTA was 181.2°, and the %MA was 11.3%, indicating moderate to severe varus deformity. The mean correction angle of 12.8° resulted in a significant decrease JLCA in standing from 4.8° to 2.7°. Therefore, careful preoperative planning considering JLCA changes is essential for HCWHTO. On the other hand, in our similar study at medial open wedge HTO (MOWHTO), the preoperative FTA was 177.0°, and the %MA was 30.8, indicating not severe varus deformity. Both the mean correction angle of 8.3° and the preoperative standing JLCA in standing of 2.4° were small, so there were no significant differences in JLCA in standing between before and after surgery. Therefore, adjustments for JLCA changes may not be necessary in preoperative planning for MOWHTO.
Conclusion
This study demonstrated that JLCA in standing significantly decreased from 4.8° preoperatively to 2.7° postoperatively. Thus, for cases of moderate to severe varus deformity indicated for HCWHTO, it is imperative to consider JLCA changes in preoperative planning to optimize correction and avoid overcorrection. The necessity of individualized planning considering soft tissue laxity changes when performing HCWHTO.

OS3-1

Change of the lateral joint space width is similar, but improvement of knee score is greater in patients with a non-discoid than in those with a discoid lateral meniscus after open wedge high tibial osteotomy

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Introduction/Purpose: Although several studies reported that osteoarthritis (OA) of the lateral compartment may progress after open wedge high tibial osteotomy (OWHTO) in patients with a discoid lateral meniscus, comparison of the clinical outcomes between non-discoid and discoid lateral meniscus is rarely reported in literature. Therefore, the purpose of this retrospective study is to compare the radiologic and clinical outcomes between the discoid and non-discoid groups following OWHTO.
Material and Methods: Inclusion criteria were patients who underwent OWHTO for the medial compartment OA from June 2000 to October 2023. The patients checked preoperative magnetic resonance imaging (MRI) scans. Patients whose preoperative MRI are not available, who were followed less than 18 months, or were planned for total knee arthroplasty for the medial compartment OA were excluded. Patients were allocated into discoid and non-discoid groups according to the preoperative MRI. Preoperative and follow-up mechanical axis ratio (MAR), lateral joint space width (LJSW), change in LJSW, hip-knee-ankle (HKA) angle were compared between the discoid and non-discoid groups. Lysholm score (LS), Knee Society knee score (KS) and function score (FS), and changes of each score between preoperative and postoperative period were compared and analyzed between the two groups.
Results: 87 patients were included in this study. 17 patients had a discoid lateral meniscus and 70 did not. Age, BMI, follow-up duration, and preoperative LJSW of the two groups did not differ. Preoperative MAR of the discoid group was significantly lower than that of non-discoid group (p=0.009). Postoperative MAR, HKA angle, LJSW, or the change of the LJSW did not show significant difference between the two groups. LS, KS, FS, and change of each score did not differ between the two groups. However, multivariate analysis of covariance showed that mean knee score improvement of the non-discoid group was significantly greater than discoid group (p = 0.045).
Conclusion: Change of the LJSW is similar, but improvement of KS is greater in patients with a non-discoid than in those with a discoid lateral meniscus after OWHTO.

OS3-2

Remodified Mason-Allen suture technique concomitant with high tibial osteotomy for medial meniscus posterior root tears improved the healing of the repaired root and suppressed osteoarthritis progression

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-Introduction/Purpose
To evaluate the results of the remodified Mason–Allen suture technique concomitant with high tibial osteotomy (HTO) for medial meniscal posterior root tears (MMPRTs). The hypothesis was that this procedure would improve clinical results, prevent progression of knee osteoarthritis and increase the healing rate of the repaired root.
-Material and Methods
Total 17 patients of mean 51.5 ± 4.4 years who were underwent this combined procedure for MMPRT completed this study. Lysholm and Hospital for Special Surgery (HSS) scores, Kellgren–Lawrence (KL) grade reflecting osteoarthritis progression were evaluated preoperatively and at the last follow-up. Medial meniscus extrusion (MME) was measured on magnetic resonance imaging preoperatively and at mean 26.1 ± 2.3 months postoperatively. Second-look arthroscopy was performed at mean 25.1 ± 5.3 months postoperatively. The healing status of the repaired root was classified as complete, partial and failed healing. The Outerbridge (OB) grade of the medial femoral condyle (MFC) was compared between index surgery and second-look arthroscopy.
-Results
Mean follow-up duration was 66.4 ± 6.5 months. Mean Lysholm and HSS mean scores improved significantly from preoperatively to the last follow-up: Lysholm: 56.9 ± 5.4 to 83.5 ± 6.0 ($P < 0.001$); HSS: 56.1 ± 6.0 to 81.7 ± 7.7 ($P < 0.001$). The mean mechanical alignment of the lower extremity was corrected from varus to the neutral range at the last follow-up. The preoperative KL grade was not significantly different from the KL grade at the last follow-up ($P = 0.071$). On MRI, mean MME increased from 3.0 ± 0.7 mm to 3.1 ± 0.7 mm ($P = 0.046$). Second-look arthroscopy showed 64.7% complete, 29.4% partial and 5.9% failed healing of the repaired root. The initial OB grade of the MFC showed no progression ($P = 0.103$).
-Conclusion
The remodified Mason–Allen suture technique concomitant with HTO for MMPRTs significantly improved clinical outcomes and suppressed OA progression at 66.4 months. However, this procedure produced limited complete healing of the repaired roots in 64.7% of patients.

OS3-3

Comparison of functional outcomes and 15 years survivorship of Medial Opening Wedge High Tibial Osteotomy in kissing vs non kissing lesion patients

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-Introduction : Medial Open Wedge High Tibial Osteotomy (MOWHTO) is a well-established treatment for medial unicompartmental osteoarthritis (OA) of the knee. However, its long-term outcomes in patients with kissing lesions (KL) versus non-kissing lesions (NKL) remain unclear.
-Methods : This retrospective study included patients who underwent MOWHTO in 2009-2010. Lesions were classified as KL or NKL based on arthroscopic evaluation. Functional scores were recorded preoperatively and at multiple postoperative intervals. Fifteen-year survivorship was assessed, with conversion to total knee arthroplasty considered as failure.
-Results : A total of 155 knees were analyzed—43 with KL and 112 with NKL. The KL group showed significantly lower survivorship and worse functional outcomes compared to the NKL group over 15 years of follow-up.
-Conclusions : MOWHTO remains a viable surgical option for active, middle-aged patients with medial compartment OA, providing good midterm results in both KL and NKL groups. However, long-term data suggest significantly reduced survivorship and functional outcomes in patients with KL.

OS3-4

Pullout Repair with Double-Plate Fixation via Inverted High Tibial Osteotomy for Medial Meniscus Posterior Root Tear with Severe Varus Tibial Deformity

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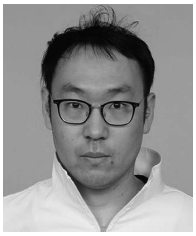
-Introduction/Purpose
Medial meniscus (MM) posterior root tears (PRTs) disrupt hoop stress and accelerate the progression of knee osteoarthritis (OA). In patients with risk factors for OA progression-such as high body mass index, pronounced varus alignment, or high activity levels, high tibial osteotomy (HTO) is frequently indicated, sometimes in combination with MMPRT repair. Although medial open-wedge HTO is typically the first-line osteotomy technique, closed-wedge HTO (CWHTO) may be preferable for patients requiring large correction angles to prevent hinge fracture and to facilitate reliable bone healing. One variant of CWHTO, the inverted V-shaped HTO (iV-HTO), offers several advantages: preservation of the hinge reduces intraoperative instability and promotes bone healing, and rotation around the hinge near the center of rotation of angulation maintains lower-extremity length whereas minimally affecting patellofemoral height. Herein, we describe a surgical technique that combines MMPRT pullout repair with iV-HTO using double-plate fixation.
-Surgical Technique
A skin incision is made over the anteromedial aspect of the proximal tibia to facilitate pullout repair and medial plate placement, followed by arthroscopic MMPRT repair. After performing a pie-crusting technique, two simple stitches are placed in the torn MM posterior root, and the sutures are passed through a tibial bone tunnel carefully created proximally to avoid crossing the osteotomy site. A fibular osteotomy is performed at the mid-shaft level at approximately 30° relative to the long axis of the fibula. iV-HTO is then performed as previously described. Immediately prior to lateral plate screw fixation, a cannulated drill is reinserted into the pullout tunnel as a protective sleeve to prevent interference between screws and the sutures. The lateral plate is applied, autograft from the lateral closed-wedge resection is placed into the medial open-wedge defect, the medial plate is fixed, and the pullout sutures are secured. When fibular displacement is minimal, fixation is achieved using strong suture ligation; in cases of substantial displacement or instability, intramedullary wire fixation is performed as needed.
-Discussion
Several studies have reported favorable effects of concomitant pullout repair on clinical outcomes, MM extrusion, medial joint space width, cartilage regeneration, and return-to-sport rate. However, other studies have not demonstrated significant differences between HTO performed with versus without pullout repair. Comparative analyses suggest that patients undergoing HTO for MMPRT without pullout repair may experience inferior clinical scores and increased MM extrusion compared with non-MMPRT knees, indicating that leaving MMPRT unaddressed—even after HTO—can accelerate medial compartment OA progression due to loss of the meniscal hoop mechanism. Biomechanical studies have also shown that pullout repair further reduces medial compartment pressure after HTO. The present technique ensures secure pullout fixation even when tunnel–implant interference is present, and the double-plate construct may facilitate earlier postoperative weight-bearing and accelerated rehabilitation. Fibular nonunion has been reported to cause lateral leg pain and tenderness at the osteotomy site. Intramedullary wire fixation is therefore a useful option in cases where suture ligation alone results in residual displacement or instability.
-Conclusion
We describe a surgical technique combining MMPRT pullout repair with iV-HTO using double-plate fixation, which facilitates secure pullout suture fixation and provides superior initial stability.

OS3-5



High Tibial Osteotomy with Individualized Alignment and Meniscal Centralization Improves KOOS Sports and Recreation and Cartilage Status Compared to Conventional Fujisawa-Point Alignment without centralization: A Propensity Score Matching Study.

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Purpose: This study was performed to compare clinical outcomes of medial opening-wedge high tibial osteotomy (MOWHTO) with individualized alignment and medial meniscus centralization versus conventional alignment targeting the Fujisawa point without centralization using propensity score matching. It was hypothesized that the individualized approach with centralization would not be inferior to conventional HTO targeting the Fujisawa point.

Methods: This retrospective matched case–control study analyzed 161 consecutive knees treated with MOWHTO. After applying uniform exclusion criteria and 1:1 propensity score matching for demographic, radiographic, and meniscal factors, 24 knees with HTO and centralization and 24 control knees were compared. The centralization group received individualized alignment based on patient characteristics, targeting a weight-bearing line (WBL) ratio of 57.0%–62.5%, whereas the control group followed the standard 62.5% WBL target. The primary outcome was the Knee Injury and Osteoarthritis Outcome Score (KOOS). The secondary outcomes were radiographic alignment and International Cartilage Repair Society (ICRS) cartilage grade on second-look arthroscopy.

Results: The mean follow-up duration was 2.5 ± 0.4 years in the centralization group and 2.5 ± 0.5 years in the control group. Both groups showed significant improvements in all KOOS subscales from preoperative to final follow-up (all $p < 0.01$). Final KOOS values were comparable, except for a higher Sports and Recreation score in the centralization group (72.8 ± 21.1 vs. 56.1 ± 27.5; $p = 0.039$). Postoperative alignment was more neutral in the centralization group (WBL ratio 51.9% ± 8.7% vs. 61.4% ± 7.6%; $p < 0.001$). Improvement in the ICRS grade of the medial femoral condyle was observed in 54.2% of knees in the centralization group compared with 12.5% in the control group ($p = 0.001$).

Conclusion: MOWHTO with individualized alignment and medial meniscus centralization achieved clinical outcomes not inferior to conventional alignment targeting the Fujisawa point without centralization.

Oral Presentation 4 AKO with additional surgery 2

OS4-1

Repair of medial meniscus posterior root tear using all-inside meniscal repair device is not necessary during open wedge HTO

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-Introduction/Purpose

This study evaluated the clinical, radiologic and arthroscopic results of medial meniscus posterior tear (MMPRT) repair using an all-inside meniscal repair device combined with a high tibial osteotomy (HTO) compared to cases without MMPRT repair during the HTO.

-Material and Methods

A total of 38 patients who underwent open-wedge HTO using a locking plate were evaluated. The mean age was 57.3 (range, 35–65) years. 38 patients had MMPRT on preoperative magnetic resonance imaging (MRI) and intraoperative arthroscopic evaluation. During HTO, meniscal repair using all-inside meniscal repair device was performed in 24 cases (repair group). In 14 cases with MMPRT, only partial meniscectomy of the movable torn meniscus was conducted (no repair group). At postoperative 2 years, second look arthroscopic evaluation for meniscus healing and cartilage regeneration was performed. Clinical results (HSS score, Knee society knee score, function score and WOMAC score) and radiologic results including K-L grace and medial joint space were also compared.

-Results

In arthroscopic evaluation, the condition of cartilage in the medial compartment improved after HTO in both group. In the repair group, MMPRT was healed in 22 of 24 cases (92%). In the no repair group, 10 of 14 cases (71%) were healed. But there was no significant difference statistically (p=0.167). Medial joint space was increased (2.6 to 3.2mm in the repair group, and 2.4 to 3.2mm in the no repair group, respectively) and HSS score, Knee society knee and function scores, and WOMAC scores were all improved after HTO in both group and there were no differences. However, the osteoarthritis by K-L grade progressed after HTO in both group, and there was no difference between two group.

-Conclusion

There was no difference in arthroscopic, clinical and radiographic results after HTO regardless of MMPRT repair using the all-inside meniscal suture device. In patients with MMPRT, repair using all-inside meniscal repair device is not necessary during HTO.

OS4-2

Leave It or Repair It? Comparison of the Arthroscopic and Clinical Outcomes after High Tibial Osteotomy with or without Medial Meniscus Posterior Root Repair

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-Introduction/Purpose

There is still no consensus on whether a concurrent medial meniscus posterior root (MMPR) repair is beneficial in combination with a high tibial osteotomy (HTO) for the treatment of posterior medial meniscus root tear with varus deformity. The objective of this study was to evaluate the necessity of concurrent repair of PMMR during the primary HTO procedure. We hypothesized that concurrent MMPR repairs affect the healing rate of MMPR tear (MMPRT) and cartilage-preserving rate; therefore would be beneficial for clinical outcomes.

-Material and Methods

The medical record of patients who underwent HTO between 2014 to 2023 was studied retrospectively. Of 47 patients, 26 patients underent HTO with either arthroscopically-assisted shaving arthroplasty or partial meniscectomy (Group A) and 21 underwent a concurrent MMPR repair using tibial bone tunnel pullout suture repair technique during HTO (Group B). The healing status of the MMPRT was categorized into healed, partially healed, and non-healed conditions. Outerbridge classification was used to evaluate cartilage preservation. Clinical outcomes were evaluated according to the Lysholm score, IKDC, and KOOS.

-Results

After a minimum follow-up of 24 months, all osteotomies had healed and the clinical outcomes showed no significant differences between the two groups ($P<0.05$). 20 (76.9%) patients in group A and 14 (66.7%) patients in Group B underwent second-look arthroscopy at least one year following the primary surgery during hardware removal. Group B exhibited a higher healing rate (92.9% to 40.0%, P=0.0028) and higher but insignificant cartilage preservation rate in group B (78.9% to 92.3%, P=0.366). This leads to the interpretation that healing rate and cartilage preservation rate are not correlated with clinical outcome scoring.

-Conclusion

Concurrent MMPR repair during HTO showed a better MMPR healing rate and a non-significant trend toward higher cartilage preservation at short- to mid-term follow-up. However, the improved healing rate was not associated with higher clinical scores. Longer-term follow-up is needed to draw deeper and more comprehensive conclusions.

OS4-3

Long-Term (>10-Year) Outcomes of High Tibial Osteotomy Versus Medial Meniscus Posterior Root Repair in Degenerative Knees with MMPRT's

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Introduction/Purpose
Medial meniscus posterior root tears (MMPRTs) compromise meniscal hoop tension and accelerate medial compartment degeneration. Both high tibial osteotomy (HTO) and anatomic root repair (RR) are established treatments, but data directly comparing their outcomes beyond 10 years remain scarce. The purpose of this study was to compare long-term clinical outcomes between medial opening-wedge HTO and arthroscopic RR in patients with degenerative MMPRTs and mild varus alignment. The objective was to assess if the corrective realignment provided by HTO translates into superior long-term outcomes and greater achievement of clinically meaningful improvement.
Material and Methods
A retrospective comparative study was conducted involving 131 patients (HTO group, n =66; Root Repair group, n = 65) who were followed for more than 10 years. Baseline characteristics, including preoperative Knee Society Score (KSS), KSS Function Score(KSSF), age, and BMI, were compared using Welch's t-test and confirmed to be statistically comparable. Primary outcome measures at final follow-up included the objective KSS, the patient-reported Oxford Knee Score (OKS), the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), and the magnitude of improvement (ΔKSS and ΔKSSF). Statistical significance for all outcomes was set at P < 0.05.
Results
The HTO group demonstrated statistically superior final scores and a significantly greater magnitude of overall recovery compared to the Root Repair group. Final Attained Status:The HTO group achieved a significantly higher mean final KSS score (93.33 ± 11.79) compared to the Root Repair group (84.12 ± 10.60) (P < 0.001), confirming superior long-term objective clinical status. Similarly, HTO achieved a significantly superior final patient-reported OKS (42.03 ± 2.12 versus 39.92 ± 3.48) (P < 0.001). Magnitude of Recovery: HTO demonstrated a significantly greater average magnitude of overall improvement (ΔKSS, P =0.032) and superior functional recovery magnitude (ΔKSSF, P = 0.012). The mean difference
for ΔKSSF was +13.43 points in favor of HTO, exceeding the threshold for clinical relevance (MCID). Equivalence: Final KSSF scores (P = 0.837) and WOMAC symptom scores (P = 0.185) were statistically equivalent, demonstrating that both procedures yield equivalent functional outcomes and symptomatic relief.
Conclusions
At >10-year follow-up, both high tibial osteotomy and arthroscopic medial meniscus posterior root repair provided durable clinical improvement in patients with degenerative MMPRTs. However, medial opening-wedge HTO achieved higher mean functional scores,greater magnitude of recovery, and superior MCID attainment, underscoring its sustained biomechanical advantage for long-term knee preservation in varus-aligned, degenerative knees.

OS4-4

High tibial osteotomy reduces the distraction force at the tear site in medial meniscus tear of posterior segment: A porcine biomechanical study

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Introduction: Previous biomechanical high tibial osteotomy (HTO) studies have examined contact pressure and medial meniscus extrusion. However, the effect of HTO on the distraction force at the tear site for medial meniscus (MM) radial tear remains unknown. We hypothesized that HTO reduces the distraction force exerted at the tear site in the middle and posterior segments. Hence, this study aims to clarify the distraction force at the tear site in the middle and posterior segments under loading conditions after medial meniscus repair (MMR) for a radial tear, before and after HTO, by measuring the tensile force applied to the suture using freshly-frozen porcine knees, a robotic system, and a load cell.
Methods: Ten freshly-frozen porcine left knees were tested using a robotic system with 6 degrees of freedom. The tensile force on the repair suture was measured using a load cell. A complete MM radial tear was created in the posterior segment, 10 mm from the posterior root. Each knee was tested under two conditions, MMR and MMR+HTO. MMR was performed using the inside-out technique with No. 3 polyester suture and horizontal sutures (which involve placing a single stitch between the central and peripheral rim). The middle segment suture was pulled tangentially laterally, whereas the posterior segment suture was pulled tangentially medially. We connected the middle segment suture to the lateral load cell to measure the tensile force for the medial direction. The posterior segment suture was connected to a medial load cell to measure the tensile force for the lateral direction. An axial load of 300 N was applied at 30°, 60°, and 90° flexion. Tensile force was calculated as the difference between the maximum tension under axial load and the initial tension. Medial open-wedge HTO was performed with a correction angle of 10°. The experiments were repeated thrice for each knee, and the median values were used. Statistical analysis was performed using a two-factor repeated-measures analysis of variance. A paired t-test was used for post-hoc analysis with Bonferroni correction. Statistical significance was set at $p < 0.05$.
Results: The tensile forces exerted on the repair sutures for the medial direction at 30°, 60°, and 90° flexions were 5.3/4.9 (MMR/MMR+HTO), 6.0/5.2, and 16.4/9.5 N, respectively. For the lateral direction, the tensile forces exerted on the repair sutures at 30°, 60°, and 90° flexions were 2.3/1.3, 5.2/5.0, and 15.5/9.1 N, respectively. The tensile forces of MM radial tears for medial and lateral directions varied significantly with knee flexion angles in MMR and MMR+HTO. At 90° flexion, the tensile forces for medial and lateral directions were significantly greater in MMR than in MMR+HTO ($p<0.001$, <0.001).
Conclusions: The most important finding of this study was that the tensile force exerted on the repaired suture at 90° of knee flexion was significantly lower in the MMR+HTO than MMR alone. In addition, the tensile forces of MM radial tears for medial and lateral directions varied significantly with the knee flexion angles in MMR and MMR+HTO. HTO reduced the distraction force exerted at the tear site in the middle and posterior segments of MM radial tears.

OS4-5

Time-Dependent Anchor Hole Expansion May Associate With Meniscal Extrusion After Open-Wedge High Tibial Osteotomy Combined With Medial Meniscus Posterior Root Tear Repair and Meniscal Centralization

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-Introduction: This study evaluated time-dependent changes in anchor hole width (AHW) and their association with postoperative medial meniscus extrusion (MME) in patients under-going open-wedge high tibial osteotomy (OWHTO) with medial meniscus posterior root tear (MMPRT) repair and meniscal centralization.
-Material and Methods: Thirty knees treated with combined OWHTO and MMPRT repair using the centraliza-tion technique were retrospectively reviewed. MRI, CT, and second-look arthroscopy were performed preoperatively and postoperatively. AHW of the MMPRT anchor and two centralization anchors (midbody and midbody–posterior, M-anchor and MP-anchor) were measured on multiplanar reconstruction CT images at 1, 3, 6 months, and 1 year, and their correlations with postoperative MME were analyzed.
-Results: AHW increased up to 3 months and gradually decreased with surrounding sclerosis by 1 year. The M-anchor showed significantly greater mediolateral (ML) expansion than the MP-anchor and demonstrated a moderate positive correlation between 1-year AHW and MME ($r \approx 0.5$, $P < 0.01$). Second-look arthroscopy confirmed a 90% healing rate of the repaired root.
-Conclusion:Although OWHTO combined with MMPRT repair and centralization achieved favor-able root healing, postoperative MME progression was not fully prevented. Time-dependent ML anchor hole expansion around the M-anchor may indicate persis-tent micromotion, elongation of the meniscotibial ligament, and degenerative stretch of the repaired meniscus following healing, suggesting that even after successful root healing, ML motion remains difficult to control, highlighting the need for biomechani-cally optimized fixation.

Oral Presentation 5 CWHTO and TCVO 1

OS5-1

Comparative Analysis of Bone Resection Volume and Lateral Overhang in Four Closed-Wedge High Tibial Osteotomy Techniques

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Purpose: This study aimed to quantitatively compare the resected bony wedge volume and evaluate discrepancies in the non-overlapping lateral osteotomy surface areas among four closed-wedge high tibial osteotomy (CWHTO) techniques. Materials and Methods:Eleven knees from 10 patients who underwent high tibial osteotomy at our hospital(2016–2023) were analyzed using preoperative three-dimensional computed tomography.

Representative cases were selected based on sex, the presence of proximal tibia vara, and a high joint line convergence angle. A subgroup analysis was then conducted. Surgical

simulations were performed on reconstructed bone models using four different CWHTO techniques (conventional, oblique, hybrid 2:1, and hybrid 3:1) at three target angles (12˚, 15˚, and 18˚). Osteotomy surface area and bony wedge volume were calculated and compared.

Results: Distal osteotomy surface areas for the oblique, hybrid 1, and hybrid 2 techniques were 91%, 83%, and 72% of the conventional technique, respectively. Resected bony wedge volumes were 86%, 52%, and 38% of the conventional technique, respectively. Volumes decreased in the order of conventional, oblique, hybrid 3:1, and hybrid 2:1. Hybrid techniques showed significantly smaller resection volumes than the conventional and oblique techniques. The non-overlapping lateral osteotomy surface areas for oblique, hybrid 1, and hybrid 2 were 41% (lateral), 22% (medial), and 22% (medial) of the conventional technique, respectively. Only the conventional technique showed a statistically significant difference.

Conclusions: Hybrid CWHTO techniques resulted in less bony wedge resection and fewer non-overlapping osteotomy surfaces compared with conventional and oblique techniques.Hybrid CWHTO may offer potential advantages in bone stock preservation and reduced lateral overhanging area.

OS5-2

Peroneal Palsy and Nonunion After Closing Wedge High Tibial Osteotomy: Does Surgical Technique Matter?

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-Introduction : High tibial osteotomy (HTO) is a standard procedure for treating unicompartmental knee osteoarthritis with varus malalignment. Lateral closing wedge hybrid HTO requires managing the fibula for proper tibial correction. This study compares the outcomes of two distinct techniques- segmental fibular excision and oblique osteotomy, focusing on nonunion at the fibular osteotomy site and peroneal nerve palsy.

-Methods : A retrospective study of 85 patients who underwent lateral closing wedge hybrid HTO. Patients were divided into fibular excision (n=53) and fibular oblique osteotomy (n=32) groups and were followed up for 2 years.Clinical outcomes included union rates, nonunion, delayed union, revisions, and peroneal nerve palsy incidence.PROMs like Oxford Knee Score(OKS),WOMAC Score,Knee Society Score(KSS) and Knee Society Score-Function(KSSF) with treatment were evaluated.Radiological assessment included Pre and post operative FTA angle, and presence or absence of non union at the fibular site.Chi-square tests were used for statistical analysis.

-Results : At a minimum 2- year follow up, there were no statistically significant differences in the mean FTA,KSS and KSSF scores of both the groups.Union rates were 30% (n=16) in fibula excision and 71% (n=23) in oblique osteotomy group. Nonunion was 66% (n=35) in excision and 18% (n=6) in oblique (p<0.001).Only 2 patients out of 41 non union(4.87%) had pain at fibular site and required revision.Peroneal nerve palsy occurred in 15 patients (18.8%; 8 in excision [15%], 7 in oblique [21%];(p>0.05) with no statistical significant difference.

-Conclusion : Fibular oblique osteotomy yields comparatively higher union rate than fibular excision.No significant difference in peroneal nerve palsy incidences between the two techniques.

OS5-3

Development and Clinical Evaluation of a Flexible Spring Plate Insole to Prevent Postoperative Deformity Following HCWHTO: Effects on Lateral Tibial Acceleration and Calcaneal Pronation

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-Introduction/Purpose: Hybrid Closed Wedge High Tibial Osteotomy (HCWHTO) is a widely adopted surgical intervention for medial compartment knee osteoarthritis (KOA), aiming to shift the mechanical axis laterally and reduce medial joint loading. Despite its effectiveness, postoperative recurrence of varus deformity remains a concern, often exacerbated by improper gait mechanics. Lateral heel wedges are commonly prescribed to counteract this, but they may induce excessive calcaneal pronation, leading to secondary issues such as flatfoot or ankle pain. A key biomechanical indicator of postoperative deformity is increased lateral tibial acceleration during heel strike. While elevating the lateral heel via insoles can reduce this acceleration, it risks promoting pronation. Therefore, a novel insole that adapts its heel height according to the gait phase—providing lateral support during heel strike and minimizing elevation during full foot contact—may offer a solution.This study aimed to develop a phase-adaptive insole capable of controlling lateral tibial acceleration and calcaneal pronation during gait in patients who had completed HCWHTO, and to evaluate its biomechanical efficacy compared to conventional insoles.
-Material and Methods: A prototype insole was designed with multiple pressure-responsive support mechanisms positioned based on COP (Center of Pressure) imaging. These mechanisms elevate the lateral heel during heel strike and retract during full foot contact. A preliminary trial was conducted with healthy participants under three conditions: no insole, fixed-height insole, and phase-adaptive insole. Subsequently, a clinical trial was performed involving 15 patients (18 knees) diagnosed with medial KOA who had completed HCWHTO and achieved bone union, with postoperative %Mechanical Axis (%MA) < 60%. Participants (mean age 67 years, BMI 25.3 ± 2.5, postoperative duration 1026 ± 615 days) completed a 5-meter walk at 100 BPM under three randomized conditions: (1) flexible spring plate insole (adaptive), (2) rubber insole (fixed), and (3) no insole (control). Lateral tibial acceleration was measured using an inertial sensor (Trigno, Delsys, USA) placed below the fibular head. Calcaneal pronation angle was assessed using a two-axis goniometer (W110, Biometrics, UK) attached to the calcaneus and posterior lower leg. Radiographic parameters (%MA, MPTA, mLDFA, JLCA, KJLO, AJLO, KAJA) and foot morphology (Foot Posture Index-6) were also evaluated. Repeated measures ANOVA with Bonferroni correction was used for statistical comparison. Correlations between Δ calcaneal pronation angle and other metrics were analyzed using Spearman's rank correlation.
-Results: In the healthy cohort, the phase-adaptive insole significantly reduced lateral knee acceleration and suppressed excessive pronation compared to fixed-height insoles. In the clinical trial, lateral tibial acceleration was significantly lower in both insole groups compared to control (flexible spring plate: 1.16 ± 0.39 G, rubber: 1.22 ± 0.50 G, control: 1.48 ± 0.46 G; $p < 0.01$), with no significant difference between the two insoles. Calcaneal pronation angle was significantly increased only in the rubber group (flexible spring plate: 11.8 ± 4.4°, rubber: 13.2 ± 6.7°, control: 11.4 ± 6.8°; $p < 0.05$). Δ calcaneal pronation angle correlated positively with baseline calcaneal mobility ($r = 0.64$), but showed no significant correlation with radiographic parameters or FPI-6.
-Conclusion: The flexible spring plate insole effectively reduced lateral tibial acceleration without exacerbating calcaneal pronation, unlike conventional rubber insoles. In patients with high calcaneal mobility, this design may offer superior protection against ankle discomfort and postoperative deformity recurrence. These findings support the clinical utility of gait-phase-responsive insoles in postoperative KOA management and highlight the importance of dynamic support strategies in orthopedic rehabilitation.

OS5-4

Clinical Significance of Fibular Management in Closed-Wedge High Tibial Osteotomy: Comparison Between Conventional Dissection and AOOL Techniques

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-Introduction/Purpose
In closed-wedge high tibial osteotomy (CWHTO), fibular management is mandatory because tibial correction cannot be achieved without releasing the fibula. Various techniques have been reported, including the conventional dissection method and the recently introduced the Acute Oblique Osteotomy and Suture Ligation (AOOL) procedure. Although AOOL has demonstrated a higher rate of fibular union and favorable short-term outcomes, some patients still experience tenderness or activity-related pain even after complete union. This study aimed to compare the fibular healing status and postoperative symptoms between the dissection method and AOOL procedure and to clarify the potential causes of residual fibular discomfort.
-Material and Methods
A total of 108 knees that underwent CWHTO were retrospectively analyzed. Patients were divided into two groups according to the fibular management method: the Dissection (D) group (n=87) and the AOOL group (n=21). Postoperative fibular status was classified into three types: - S: Separate - NU: Non-union - U: Union Symptoms at the fibular site were categorized as:
(1) No symptoms, (2) Tenderness, (3) Activity-related pain, and (4) Tenderness and Activity-related pain. Comparisons between groups were performed using the chi-square test.
-Results
A significant difference in fibular healing status was observed between the D group and AOOL groups ($\chi^2=6.654$, $p=0.036$). The AOOL group showed a higher rate of union (U type: 57%, NU type: 43%) compared with the D group. There was also a significant association between fibular healing status and clinical symptoms ($\chi^2=42.281$, $p<0.001$). These findings suggest that postoperative symptoms are influenced by the condition of the fibula.
-Conclusion
This study demonstrated that the fibular healing status is closely associated with postoperative fibular symptoms.
Although the AOOL technique achieved a higher union rate than the conventional dissection method, it did not completely eliminate postoperative discomfort.
These results indicate that surgical invasion itself may contribute to symptom development.
Based on these findings, we have attempted proximal tibiofibular joint disruption (PTFJ-D) as an alternative to fibular osteotomy.
The initial impression has been favorable, and this technique will also be briefly introduced in the presentation.

OS5-5

Extension-Type Checkrein Deformity of the Hallux Following Closed-Wedge High Tibial Osteotomy: A Case Report

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Background: Checkrein deformity is classically characterized as rigid flexion of the interphalangeal joint in ankle dorsiflexion but with flexibility in ankle plantarflexion, most commonly attributed to tethering, adhesion, or entrapment of the flexor hallucis longus (FHL) after fractures or surgery around the distal tibia, ankle, or hindfoot. In contrast, an extension-type checkrein deformity of the hallux, - defined by rigid extension of the first metatarsophalangeal joint during ankle plantarflexion and flexibility during ankle dorsiflexion due to extensor hallucis longus (EHL) dysfunction related to extra-tendinous tethering- is exceedingly rare. To our knowledge, no previous reports have described an extension-type checkrein deformity as a complication after closed-wedge high tibial osteotomy (HTO) with fibular osteotomy .

Case Presentation: A 48-year-old man underwent left lateral closing-wedge HTO with concomitant fibular osteotomy for medial compartment knee osteoarthritis. The immediate postoperative course was uneventful. At the 6-month follow-up, he complained an inability to flex the left great toe when the ankle was planterflexed, without any history of trauma, infection, or neurologic symptoms. Physical examination revealed rigit extension of the left great toe during ankle plantarflexion but preserved motion during dorsiflexion. The lesser toe extensors were intact, and ankle strength and sensation within the deep and superficial peroneal nerve distributions were normal. Plain radiographs demonstrated expected post-osteotomy alignment without hardware complications. These findings suggested an extension-type checkrein deformity of hallux, likely secondary to EHL dysfunction caused by extra-tendinous scarring or altered tendon gliding associated with prior fibular osteotomy and compartmental fibrosis, rather than a primary EHL tendon rupture.

Surgical Management: Through an anterior approach, the EHL was identified as intact but with restricted excursion. Given concern for proximal tethering not amenable to local adhesiolysis alone,the EHL was transected at the ankle level, and anastomosed to the EDL using an interlacing suture with the ankle in neutral and the hallux in slight extension. Intraoperative testing confirmed physiological motion of hallux without excessive tension in ankle plantarflexion.

Postoperative Course: The foot was immobilized for 4 weeks with the hallux maintained in neutral-to-slight extension for soft-tissue protection. Subsequently, progressive active range-of-motion exercises and extensor retraining were initiated, followed by strengthening. The patient achieved functional active hallux extension, improved push-off during gait and reported resolution of shoe-wear difficulties. No wound or neurovascular complications occurred.

Discussion: While most HTO-related complications involve alignment errors, nonunion, peroneal neuropathy, or compartment issues, distal extensor dysfunction causing an extension-type checkrein deformity of the hallux remains under-recognized, especially when a fibular osteotomy is performed. Potential mechanisms include scar formation or compartmental adhesions restricting EHL excursion, altered fascial planes, or subclinical ischemic changes rather than frank tendon rupture. This case underscores distinct diagnostic features that distinguish extension-type checkrein from classical FHL-driven flexion-type deformity. When local adhesiolysis is inadequate or the exact site of tethering uncertain, EHL transfer to EDL provides a reliable biomechanical solution, ensuring predictable tensioning and facilitating straightforward rehabilitation.

Conclusion: An extension-type checkrein deformity of the hallux may occur following closed-wedge HTO with fibular osteotomy and can easily be overlooked. EHL tendon transfer to the EDL represents a practical and effective strategy for restoring active hallux extension and functional recovery.

OS6-1

Two-year Outcomes of Tibial-Sided Osteotomy for Fibula Untethering in Lateral Close-Wedge High Tibial Osteotomy

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-Introduction/Purpose

Despite its advantages, lateral close-wedge high tibial osteotomy (LCWHTO) requires proximal tibiofibular joint detachment (PTFJD) or fibular shaft osteotomy for gap closing. These fibula untethering procedures are technically demanding and not free from the risk of neurovascular injuries. Our novel fibula untethering technique, tibial-sided osteotomy (TSO) near the proximal tibiofibular joint (PTFJ), aims to reduce technical demands and the risk of injury to the peroneal nerve and popliteal neurovascular structures. The purposes of this study were to compare the safety of TSO with those of radiographic virtual PTFJD and report 2-year follow-up results.

-Material and Methods

Between March and December 2023, 13 patients who underwent LCWHTO with TSO for fibula untethering were enrolled. All patients underwent MRI preoperatively and CT scanning postoperatively. The location of the TSO site on the postoperative CT scans was matched to preoperative MRI to measure the shortest distance to the peroneal nerve and popliteal artery. These values were compared with estimates of the distance between the PTFJ and neurovascular structures in the radiographic virtual PTFJD group. The protective effect of the popliteus muscle was evaluated by extending the osteotomy direction toward the posterior compartment of the knee. Finally, 2-year follow-up CT scan was taken in all patients to evaluate the osteotomy site and the PTFJ.

-Results

The TSO procedure was straightforward and reproducible without producing incomplete gap closure during LCWHTO. On axial images, the distances between the surgical plane and the peroneal nerve or popliteal artery were significantly longer in the TSO group than in the radiographic virtual PTFJD group (both $p = 0.001$). On coronal and axial MRI, the popliteus muscle covered the posterior osteotomy plane in all patients undergoing TSO but did not cover the PTFJD plane in the radiographic virtual PTFJD group. On the 2-year follow-up CT scan, all TSO were united with preservation of the PTFJ.

-Conclusion

Our novel TSO technique for fibula untethering during LCWHTO preserved the PTFJ and reduced the risk of neurovascular injury by placing the separation site more medially than in the PTFJD procedure.

OS6-2

Usefulness of Hybrid Closed Wedge High Tibial Osteotomy against ACL Deficiency, Increased Posterior Tibial Slope ,and Osteoarthritis.

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There is no clear consensus regarding the treatment of chronic anterior cruciate ligament (ACL) deficient knees. Surgical options include ACL reconstruction, osteotomy, and total knee arthroplasty. We report a case treated with hybrid closed-wedge high tibial osteotomy (H-CWHTO) with favorable outcomes.

The patient was a healthy 43-year-old woman who played futsal three times a week, including in official matches. She had undergone ACL reconstruction 20 years prior and presented with progressive left knee pain for the past six months. Range of motion showed mild flexion contracture, 10–120°. Standing long-leg radiographs revealed K-L grade 4, %MA 19%, mMPTA 82°, mLDFA 89°, indicating varus deformity; lateral view showed a posterior tibial slope of 12°. MRI revealed medial meniscus tear, ACL rupture, and cartilage lesions in the medial femoral condyle, tibial plateau, and patellofemoral joint.

Given these findings, we selected H-CWHTO, as described by Takeuchi et al., considering its potential to achieve not only pain relief but also return to sports. We obtained good clinical outcomes, and we present this case along with the postoperative course.

OS6-3

The medial collateral ligament and osteophytes affect medial meniscus extrusion after CWHTO

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Introduction: Closed wedge high tibial osteotomy (CWHTO) has been reported to allow for postoperative re-tensioning of the medial collateral ligament (MCL) which was revealed to have slackened preoperatively. Therefore, MCL re-tensioning may improve medial meniscus extrusion (MME) caused by osteoarthritis (OA) of the knee. However, there have been no reports on MME after CWHTO. The aim of this study is to examine the effect of postoperative MCL re-tensioning following CWHTO on MME and its association with clinical outcomes.

Materials and Methods: The single surgeon performed primary CWHTO on 25 knees in 20 consecutive patients between 2020 and 2024. The inclusion criteria were medial compartment OA of the knee combined with patellofemoral OA, varus alignment, no inflammatory arthritis, and no history of knee surgery.

Using an anteroposterior weight-bearing whole-leg radiograph with the knee joint in extension, the weight-bearing line ratio (WBL ratio), the medial proximal tibial angle (MPTA), the mechanical lateral distal femoral angle (mLDFA), and the joint convergence angle (JLCA) were calculated. Magnetic resonance imaging (MRI) was performed preoperatively and one year after procedure. Based on MRI, the distance between the medial tibial cortical bone and the MCL (MCL distance) and MME were measured. Computed tomography (CT) was used to calculate the size of osteophyte at the medial tibial condyle. The Knee Injury and Osteoarthritis Outcome Score (KOOS) was used to evaluate the clinical outcomes preoperatively and at the final follow-up (mean 20 months). Paired t-tests were used to compare corresponding radiographic and MRI parameters before and after CWHTO. Pearson correlation coefficient was used to examine their correlation between changes in each factor (Δ) and KOOS. Statistical significance was assumed for p values less than 0.05.

Results: The MME significantly changed from 6.3±1.5 mm preoperatively to 5.4±1.6 mm postoperatively ($p = 0.01$). The MCL distance significantly changed from 4.2 mm preoperatively to 3.2 mm postoperatively ($p = 0.01$). ΔMME showed a positive correlation with ΔMCL distance ($r=0.56$, $p=0.01$) and a negative correlation with osteophyte size ($r=-0.69$, $p=0.01$). In the 10 knees with ΔMME improvement ≥1 mm, osteophyte size was significantly smaller in the 15 knees with ΔMME improvement <1 mm (1.2±1.7 mm vs. 3.5±1.4 mm; $p=0.01$). The cut-off value for osteophyte size atΔMME improvement ≥1 mm was 1.3mm, with sensitivity and specificity of 93.3% and 70.0%, respectively ($p = 0.01$). In clinical outcomes, the mean postoperative KOOS (50.5 ± 17.0 points) showed significant improvement compared to the preoperative score (76.7 ± 13.9 points; $p = 0.01$). No significant difference was observed in preoperative and postoperative KOOS scores between the group with ΔMME improvement was ≥1 mm or not.

Conclusion:

Improvement of MME was influenced by MCL re-tensioning and osteophyte size at the medial tibial condyle following CWHTO. However, the degree of MME change did not affect postoperative clinical outcomes.

OS6-4

A study of knee joint instability and intra-articular changes before and after Tibial Condylar Valgus Osteotomy (TCVO) for osteoarthritis of the knee

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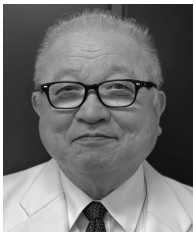
Purpose: TCVO is a joint-preserving surgery for unstable varus osteoarthritis of the knee with teeter effect, which makes HTO unsuitable, and clinical outcomes have been reported. This time, we compared the changes in knee joint instability before and after TCVO surgery, as well as changes in the meniscus on MRI images, and reported the results.

Materials and Methodd:Subjects were 38 knees that underwent TCVO for varus type of knee osteoarthritis. The mean age at surgery was 67.5 years, and the study included clinical outcomes, knee joint instability angle (KJIA) as the sum of preoperative and postoperative fluoroscopic stress tests, and MRI imaging findings before and 1 year after surgery. The brightness change of the medial meniscus on STIR images and the rate of medial deviation were compared.

Results: Clinical outcome improved from an average of 48.5 points preoperatively to 85.0 points postoperatively, KJIA improved from an average of 7.9 degrees preoperatively to 1.4 degrees, and the medial meniscus deviation rate improved from an average of 50.3% preoperatively to 17.9% postoperatively, showing a correlation trend between KJIA and medial meniscus deviation rate.

Discussion: Knee joint instability and medial meniscus deviation rate may contribute to clinical symptoms in varus type osteoarthritis, and TCVO, which aims at bicondylar simultaneous contact and brakes joint instability, is considered a joint-sparing surgery that changes the environment within the joint.

OS6-5



Tibial condylar valgus osteotomy (TCVO): Surgical technique and clinical results for knee osteoarthritis with varus deformity

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-Introduction/Purpose: The purpose of this report is that the surgical technique and clinical results of TCVO for knee OA with varus deformity.

-Material and Methods: The study cohort comprised 145 patients (34 men and 111 women) with 171 knees with medial OA who were treated with TCVO. The average age was 66.3 years. 35 knees as grade 2, 57 knees as grade 3 and 79 knees as grade 4(using KL classification) We evaluated the clinical results using the Japanese Orthopaedic Association (JOA) scores for the patient's symptoms and function of the knee joint before and after the operation. (30 points for pain and walking ability, 25 points for pain and stair walking ability, 35 points for flexion angle, and 10 points for swelling of the knee joint).An anteroposterior (AP) view of the long length roentgenogram of the lower limb (standing position) was performed for the radiological evaluation. The percentage of mechanical axis deviation (%MAD) and the medial plateau angle(MPA)(the medial angle between the articular surface of the medial plateau and the axis of the proximal part of the tibia) were measured. MPOA(medial plateau opening angle) and LPOA(lateral plateau opening angle) were measured.Also, the varus stress angle and valgus stress angle were measured as the angle between the tangential line of the medial femoral condyle and the lateral femoral condyle and the articular surface of the tibial plateau in varus and valgus stress radiographs under the image intensifier with the knee extended and flexed at 10 before and after TCVO. The total amplitude of the varus stress angle and valgus stress angle was identified as the knee joint instability angle (KJIA) before TCVO, just after TCVO and at follow up.

-Results: The average JOA score was 45.3 ± 7.5 points to 81.1 ± 8.2 points after TCVO($p < 0.0001$).The preoperative average of %MAD is from 6.8 ± 18.1%to 59.2 ± 10.3% after TCVO ($p < 0.0001$).The preoperative average of MPA significantly increased from 75.6° ± 3.4° to 90.9° ± 4.3° after TCVO($p < 0.0001$). The preoperative average of MPOA significantly decreased from 6.5° ± 2.4° to 4.3° ± 3.0° after TCVO ($p < 0.0001$). The preoprative average of LPOA significantly decreased from 15.6° ± 3.4° to 3.9° ± 2.1° after TCVO ($p < 0.0001$). KJIA with the knee extended ranged from 2.7 ± 2.4,0.21±0.65° and to 0.44 ± 0.84 ($p < 0.0001$) and KJIA with the knee flexed ranged from 6.1 ± 3.1, 0.80±1.31° to 1.4 ± 1.7 . ($p < 0.0001$) before TCVO, just after TCVO and at follow up.

-Conclusion: TCVO is indicated for all grades of varus knee OA . The fundamental principle underlying TCVO is stabilization of the knee joint through the intra-articular correction of an intra- articular deformity. TCVO stabilizes varus knee OA without the need for separate ligament reconstruction.The patients are able to return to heavy manual labor and sporting activity.

OS7-1

Where is the optimal starting point in medial open wedge high tibial osteotomy? - 3D tibia model finite element study-

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Introduction
Medial open wedge high tibial osteotomy is a well-established procedure for the treatment of unicompartmental osteoarthritis. The osteotomy plane was started from the medial cortex along the metaphyseal flare approximately 3cm distal of the joint line. However, little is known about the optimal starting point of the medial cortex. The purpose of this study was to identify the optimal starting point in medial open wedge high tibial osteotomy. The hypothesis is that the optimal starting point meets two conditions, the lowest peak von mises stress at plate and screw, and the largest surface area on osteotomy site.
Methods
A previously validated intact 3D tibial finite element model was used. The end point of osteotomy was positioned in the tip of fibula head. The starting point, proposed by a clinician, is the shortest straight line from the end point in the coronal plane. This shortest straight line makes 60° with the mechanical axis line of the tibia. Five starting points were divided by 5° intervals. In other words, the angle formed by each starting point and the mechanical axis line of the tibia is 50°, 55°, 60°, 65°, 70°, respectively. Five uniplane osteotomy models and five biplane osteotomy models were constructed with each starting point(Fig. 1). The correction height was 10mm. Fixation was achieved using Tomofix (Depuy Synthes Inc., MA, USA). The peak knee joint contact force (body weight * 2.5) was divided into 60% on the medial side and 40% on the lateral side. Peak von mises stress (PVMS) on the plate and screws was analyzed after loading. Surface area on osteotomy site was measured by 3-matics program (Materialise Inc., Leuven, Belqium).
Results
As the angle formed by each starting point and the mechanical axis line of the tibia increase in the uniplane model, PVMS was measured 198, 206, 224, 240, 243MPa at plate and 218, 211, 210, 198, 186MPa at the screw. Also the surface area of osteotomy site was measured 5386, 5451, 5457, 5705, 6076mm2. In the biplane model, PVMS was measured 200, 201, 205, 226, 243MPa at plate and 219, 214, 201, 192, 183MPa at screw. The surface area of osteotomy site was measured 5731, 5662, 5724, 5957, 6383mm2.
Conclusions
In 3D tibial finite element model study, the starting point formed by the shortest straight line with 60° had lower peak von mises stress at plate and screw, and larger surface area on osteotomy site simultaneously. However, further cadaver or clinical study will be needed.

OS7-2

The Effect of Bioabsorbable Fillers on Optimizing Screw Fixation and Enhancing Mechanical Stability in High Tibial Osteotomy

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-Introduction/Purpose
This study explores the mechanical stability of Open-Wedge High Tibial Osteotomy (OW-HTO) plates using finite element analysis (FEA), with a focus on the role of bioabsorbable fillers in maintaining structural integrity under varying screw fixation configurations. The primary goal is to evaluate the impact of polycaprolactone (PCL)-based fillers on reducing overall structural displacement and stress, providing insights for the design of more minimally invasive implants.
-Material and Methods
Finite element models were developed to assess the stability of OW-HTO plates with and without PCL-based fillers across different screw configurations. Five alternative models incorporating fillers were subjected to simulated loading conditions equivalent to 1.5 times the body weight of an average person (approximately 720N and 480N). These configurations included fully populated screw models and those with selective omission of screws in the second row or specific diaphyseal locations.
-Results
The analysis revealed that models incorporating PCL fillers experienced significant reductions in maximum stress compared to the baseline models without fillers, with stress reductions ranging from 55.77% to 58.96%. Additionally, all filler-inclusive models demonstrated lower overall structural displacement compared to the no-filler baseline, with reductions ranging from 22.65% to 28.53%. Wedge displacement analysis further indicated that the inclusion of fillers reduced movement by 12.64% to 42.72% compared to the baseline.
-Conclusion
Polycaprolactone (PCL), a biodegradable polyester known for its bioresorbability and compatibility with 3D printing for bone defect structures, has been shown to significantly enhance the mechanical stability of OW-HTO by reducing both displacement and stress in this study. These findings support the potential for using fewer screws without compromising structural integrity, thereby facilitating the development of more minimally invasive surgical techniques. Such advancements could lead to shorter recovery times and improved clinical outcomes. Future research should focus on refining the design and material properties of these fillers to further enhance their biomechanical efficacy in clinical applications

OS7-3

Proximal Fibular Osteotomy for Medial Compartment Knee Osteoarthritis: Two-Year Functional and Biomechanical Outcomes

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Introduction
Proximal fibular osteotomy (PFO) has emerged as a simple, joint-preserving procedure for managing medial compartment knee osteoarthritis by altering load distribution across the knee joint. Published literature has had mixed clinical and functional outcomes after PFO. The purpose of this study was to build on the exiting literature by evaluating two-year postoperative biomechanical, functional, and quality-of-life outcomes of patients undergoing PFO at a tertiary centre in Singapore.
Methods
A retrospective review was conducted on 63 consecutive patient who underwent PFO between 2018 and 2023. There were 22 males and 41 females with a mean age of 66.23 years. Indications for PFO included medial compartment osteoarthritis. Patients undergoing bilateral PFO, concurrent HTO and PFO, and non-native knees were excluded from the study. Clinical assessment incorporated detailed biomechanical measurements (anterior–posterior and mediolateral stability, range of motion, varus/valgus alignment, and quadriceps strength via Manual Muscle Testing). Patient-Reported Outcome Measures (PROMs) included the Knee Society Score (KSS), Oxford Knee Score (OKS), and the SF-36 quality-of-life questionnaire.
Results
Medioloateral stability improved from 14.37 to 12.46 ($p = 2.18\times10^{-5}$), with quadriceps strength increased markedly, with maximum manual muscle testing (MMT) rising from 16.37 to 20.21 kg ($p = 2.70\times10^{-6}$) and average MMT increasing from 15.38 to 18.98 kg ($p = 7.26\times10^{-6}$). Other mechanical parameters, including range of motion and varus degree, remained largely unchanged and did not show statistical improvement. Patient reported outcome measures had mixed results. The OKS decreased from 31.13 to 24.37 ($p = 1.04\times10^{-5}$). However, several SF-36 domains demonstrated improvement, including Physical Functioning ($p = 0.00121$), Role-Physical ($p = 0.00539$), Bodily Pain ($p = 0.00149$), and General Health ($p = 0.00185$). Emotional Well-being, Vitality, Social Functioning, and Mental Health remained largely similar compared to pre-operatively.
Conclusion
In this retrospective cohort of 63 knees, proximal fibular osteotomy demonstrated two-year improvements in functional knee scores, lower limb strength, mediolateral stability, and multiple quality-of-life domains. With improvements in range of motion, other biomechanical parameters, and patient perceived pain and function being limited further research would be warranted to identify patients that would most benefit from PFO.

OS7-4

Application of Custom Guide-Assisted Corrective Osteotomy for Lower Limb Deformities: A Case Series.

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Introduction: We have developed a custom guide–assisted osteotomy technique for correction of upper limb deformities. This technique enables precise three-dimensional correction according to preoperative planning. In this study, we applied the same technology to corrective osteotomy for lower limb deformities and report the surgical procedures, outcomes, and technical considerations.
Cases: All patients were around 50 years old and had sustained lower limb fractures during childhood traffic accidents. Each had undergone surgical or conservative treatment, which resulted in malunion. They were asymptomatic through their 20s to 40s but began to experience functional limitations in daily activities around the age of 50, leading them to seek treatment at our institution.
Case 1: The patient presented with osteoarthritic changes secondary to femoral malunion. Radiographs showed a varus-type knee osteoarthritis with Kellgren–Lawrence grade IV changes. Although total knee arthroplasty was considered, the patient preferred deformity correction due to his age and activity demands. Corrective osteotomy was performed under the guidance of a custom cutting guide, and fixation was achieved using a double-plate construct. Bone union was obtained one year postoperatively, the implant was removed, and the patient returned to recreational golf without symptoms.
Case 2: This patient had a tibial varus deformity secondary to malunion but showed no osteoarthritic changes in the knee or ankle. The patient complained of plantar callosity and difficulty pedaling a bicycle due to the varus alignment. Corrective osteotomy using a custom guide was performed, and fixation was achieved with double plates. However, five months postoperatively, the patient sustained a plate fracture and re-fracture while walking a dog. Revision surgery was performed with an extended plate, achieving solid bone union at 18 months after the reoperation. The implant was subsequently removed, and the patient successfully returned to cyclocross competition.
Case 3: The patient exhibited residual tibial valgus and external rotation deformities. He had previously sustained an anterior cruciate ligament (ACL) injury in his 30s and underwent ACL reconstruction, followed by re-injury after minor trauma and a subsequent re-reconstruction, which again failed. The residual deformity was considered one of the contributing factors to repeated graft failure. Therefore, corrective osteotomy was performed using a custom guide. Based on previous case 2, intramedullary nailing was selected to achieve stronger fixation. However, due to intramedullary sclerosis, insertion control was difficult, and maintenance of alignment was challenging. Although correction of external rotation was achieved, a mild valgus deformity remained. Bone union was obtained one year postoperatively, and the nail was removed, but the patient continued to experience mild ankle discomfort during exercise.
Discussion: The application of custom guide–assisted osteotomy for lower limb deformities demonstrated the feasibility of precise correction according to preoperative planning. However, unlike the upper limb, lower limb correction requires consideration of weight-bearing forces, larger bone dimensions, and higher fixation strength. Our experience suggests that while the custom guide technique developed for upper limb deformity correction can be adapted to the lower limb, fixation strength and postoperative mechanical environment must be carefully considered.
Conclusion: Custom guide–assisted osteotomy allowed accurate correction of lower limb deformities, achieving satisfactory alignment and bone union in all cases. However, the biomechanical demands of the lower extremity necessitate stronger fixation and thoughtful adaptation of the technique. Further refinement of guide design and fixation methods is warranted for safe and reliable application in lower limb deformity correction.

OS7-5

Preoperative Subchondral Bone Density Distribution Assessed by CT-Osteoabsorptiometry Predicts Clinical Outcomes After High Tibial Osteotomy

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Introduction)
Subchondral bone density reflects the cumulative mechanical loading applied to the joint surface over time, as described by Wolff's law and Frost's mechanostat theory. These concepts explain how bone adapts its internal architecture and mineralization through biologic responses to mechanical strain. In the knee joint, several biomechanical studies have demonstrated significant associations between proximal tibial bone density distribution, knee adduction moment (KAM), and lower-limb alignment. These relationships support the concept that subchondral mineralization serves as a long-term adaptive record of habitual load distribution across the tibial plateau. CT-osteoabsorptiometry (CT-OAM) is an imaging technique that enables quantitative visualization of subchondral bone density using standard clinical CT scans. By reconstructing axial slices into a plane consistent with the joint surface, CT-OAM generates a map of Hounsfield unit (HU) values, providing an indirect estimate of long-term stress patterns. The purpose of this study was to determine whether preoperative subchondral bone density distribution assessed by CT-OAM can predict postoperative clinical outcomes following medial opening wedge high tibial osteotomy (HTO) in patients with medial knee osteoarthritis (OA).
Methods)
This retrospective analysis included 82 knees that underwent HTO for symptomatic medial compartment OA. Among these, 40 knees had complete datasets consisting of preoperative CT-OAM imaging and postoperative Knee injury and Osteoarthritis Outcome Score (KOOS) at follow-up. CT images with 0.5-mm slice thickness were reconstructed along the tibial plateau to generate subchondral density maps using OsteoDens, an original CT-OAM software developed at Hokkaido University. HU values were extracted from the subchondral plate, and the high-density area (HDA) was defined as the upper 20% of HU values within the region of interest. The medial ratio—a primary parameter in this study—was calculated as the proportion of HDA located on the medial side relative to the entire plateau. Patients were classified into two groups according to whether their postoperative KOOS improvement exceeded the minimal clinically important difference (MCID). Receiver operating characteristic (ROC) analysis was used to evaluate the predictive performance of the medial ratio. Additionally, a predictive regression model incorporating hip–knee–ankle (HKA) angle and medial and lateral meniscal extrusion (MMER/LMER) was assessed to explore factors associated with density distribution patterns.
Results)
ROC analysis revealed that the preoperative medial ratio significantly predicted postoperative KOOS improvement (AUC = 0.76, $p = 0.03$). A threshold value of 90% for the medial ratio was identified, above which postoperative clinical improvement was markedly less likely. Patients demonstrating a highly medialized density pattern (medial ratio ≥90%) tended to have poorer functional outcomes after HTO. This suggests that extreme medial overload before surgery may reflect advanced or irreversible structural changes in the joint, including chronic meniscal insufficiency or prolonged asymmetric load concentration. These findings emphasize the potential value of subchondral bone density mapping as an indicator of long-standing mechanical stress that may persist despite surgical realignment.
Discussion)
CT-osteoabsorptiometry provides an effective method for visualizing and quantifying long-term subchondral loading patterns. A preoperative medial ratio of ≥90% was strongly associated with inferior postoperative KOOS improvement following HTO. These findings suggest that CT-OAM–derived density mapping may serve as a valuable preoperative imaging biomarker to guide surgical decision-making and patient counseling. Further prospective studies with larger cohorts are warranted to validate these results and clarify how CT-OAM parameters can be applied in routine clinical practice.

Oral Presentation 8 AKO coronal alignment 1

OS8-1

Constitutional Alignment is Related to Serial Alignment Change after Opening-Wedge High Tibial Osteotomy

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Background: One major issue after medial opening-wedge high tibial osteotomy (OWHTO) is the maintenance of accurate correction, especially in the coronal plane. Coronal Plane Alignment of the Knee (CPAK) classification is a comprehensive system for coronal limb alignment that addresses constitutional alignment. The purposes of this study were (1) to clarify the distribution of the CPAK phenotype in patients who underwent OWHTO and (2) to identify the predictive factors for postoperative serial alignment change after OWHTO.

Methods: Patients who underwent OWHTO between March 2014 and December 2019 were retrospectively evaluated. They were allocated to three groups according to the direction of changes in the alignment from postoperative 3 months to the final follow-up: varus direction group when the weight-bearing line ratio (WBLR) change was < – 4%, valgus direction group when the WBLR change was > 4%, and maintained group, otherwise. This study included only patients who were with a minimum of 3 years of postoperative follow-up. All radiologic evaluations were performed using whole-leg anteroposterior weight-bearing radiograph at three time points: preoperatively, 3 months postoperatively, and at the final follow-up. To assess lower limb alignment in the coronal plane, the WBLR, mechanical hip-knee-ankle angle (mHKA), joint line convergence angle (JLCA), and center of JLO (cJLO) were evaluated. In addition, the CPAK phenotypes by incorporating two variables: HKA and JLO for each status (constitutional, preoperative, and postoperative alignments) were assessed. Clinical outcomes were assessed before and final follow-up after the operation using the American Knee Society Score and the Western Ontario and McMaster Universities Osteoarthritis Index. All these evaluations were compared between the three groups.

Results: A total of 163 knees were enrolled and allocated to varus direction (72 knees), maintained (66 knees), and valgus direction (25 knees) groups. The follow-up period, target WBLR, and JLCA were not different between three groups. More varus JLO was observed in the order of varus direction, maintained, and valgus direction at all times (all $p < 0.05$). The most common CPAK type was type (V + VI) (postoperative 3 months: neutral JLO) + type (I + II) (constitutional: varus JLO) in the varus direction group (29.4%; $p = 0.000$), otherwise, the most common CPAK type was type (VIII + IX) (postoperative 3 months: valgus JLO) + type (IV +V) (constitutional: neutral JLO) in the valgus direction group (11.7%; $p = 0.000$). Clinical outcomes did not differ between the groups.

Conclusion: Constitutional and postoperative JLO were predictive factors of postoperative alignment changes after OWHTO. Constitutional varus and postoperative neutral JLO had a tendency of varus alignment progression; constitutional neutral and postoperative valgus JLO had a tendency of valgus alignment progression.

OS8-2

Medial Opening Wedge High Tibial Osteotomy - do coronal plane phenotypes matter?

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-Introduction/Purpose

CPAK Types I and II are the most common lower limb coronal phenotypes in the arthritic population. Medial opening wedge high tibia osteotomy (MOWHTO) has conventionally been indicated in Type I phenotypes. This study aims to assess and compare outcomes between Type I and II patients who undergo MOWHTO for the treatment of medial compartmental knee osteoarthritis (OA).

-Material and Methods

A retrospective study was undertaken by reviewing a database to identify MOWHTO performed between January 2019 to January 2023 for indication of medial knee OA. Biodemographic data and clinical outcome scores were collected pre-operatively and at 6-months and 2-years after surgery. Clinical scores utilized are the Oxford Knee Score, Knee Society Knee Score and the Knee Society Function Score.

Joint Line Convergence Angle (JLCA), Lateral Distal Femoral Angle (LDFA), Medial Proximal Tibia Angle (MPTA) and Hip-Knee-Ankle Angle (HKA) were measured on full-length radiographs. Patients were divided into respective pre-operative CPAK groups.

Statistical analysis was performed between Group I (CPAK Type I) and Group II (CPAK Type II), and significance was set at p-value of < 0.05.

-Results

Out of 121 cases identified, 66 (54.5%) cases were CPAK Type I and 40 (33.1%) cases were Type CPAK II. The two groups were similar in age, gender distribution, body-mass index and side of surgery. Distribution of OA severity was 14 Grade II, 18 Grade III and 34 Grade IV in Group I and 10 Grade II, 17 Grade III and 13 Grade IV in Group II. Baseline pre-operative scores were similar.

At both 6-months and 2-years after surgery, self-reported clinical scores were similar between groups. Both groups experienced significant improvements compared to pre-operative state.

-Conclusion

MOWHTO can be employed in CPAK Type II patients for the treatment of medial knee OA with comparable outcomes to CPAK Type I patients.

OS8-3

Improved Coronal Alignment Using the Preemptive Joint Line Convergence Angle Compensation Method in Medial Open Wedge High Tibial Osteotomy: A Retrospective Propensity Score-Matched Analysis

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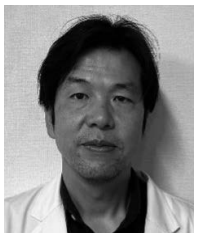
Introduction: Accurate coronal alignment is crucial in medial open wedge high tibial osteotomy (MOWHTO). Postoperative changes in the joint line convergence angle (JLCA) can cause coronal alignment errors. A preemptive JLCA compensation method has been proposed to address this, but its clinical value remains unclear.
Purpose: To access the accuracy of the preemptive JLCA compensation method for correction angle calculation in MOWHTO.
Methods: Patients who underwent MOWHTO for varus osteoarthritis alignment between 2010 and 2024 were reviewed. The patients were classified into two groups based on whether the preemptive JLCA compensation method was applied (group 1: conventional Miniaci method; group 2: preemptive JLCA compensation method). After propensity score matching for sex, body mass index, hip-knee-ankle (HKA) angle, Kellgren-Lawrence grade, and correction angle on standing radiography, we conducted a comparative analysis for radiologic outcomes (weight-bearing ratio) and functional outcomes (Lysholm score and International Knee Documentation Committee (IKDC)) scores. Acceptable alignment was defined as a postoperative weight-bearing line ratio between 55% and 70%.
Results: Twenty patients were included in each group after propensity score matching. The mean preoperative HKA angle was varus 6.2 ± 2.2° and 6.3 ± 2.2° (p=0.922), while the correction angle measured by the Miniaci method was 10.0 ± 2.1° and 10.3 ± 1.7° for the conventional and preemptive JLCA compensation method group, respectively (p=0.855). The mean postoperative weight-bearing line ratio at 1 year postoperative was 64.1 ± 7.4 and 62.5 ± 4.7 for the conventional and preemptive JLCA compensation method respectively, showing no significant difference. However, 95.0% of patients in the JCLA modification group achieved acceptable target alignment compared with 60.0% (12/20) of patients in the conventional group (p=0.014). Despite the significant difference in the accuracy of coronal alignment, functional outcomes showed no significant difference between the two groups.
Conclusions: The preemptive JLCA compensation method improved correction accuracy, with 95.0% of patients achieving acceptable target alignment, compared with a higher rate of patients with under-correction or over-correction using the conventional Miniaci method.

OS8-4



Effect of Joint-Line Obliquity on OA Progression after OWHTO

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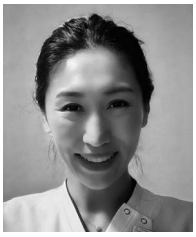
Introduction:
Medial open-wedge high tibial osteotomy (OWHTO) is widely performed for medial compartment knee osteoarthritis (OA) with varus deformity. However, increased joint-line obliquity (JLO) after osteotomy may lead to greater shear stress on the lateral compartment, possibly accelerating OA progression. Few studies have clarified the long-term influence of postoperative JLO on degenerative changes after OWHTO. The purpose of this study was to evaluate whether coronal joint-line obliquity affects the mid- to long-term progression of knee OA after OWHTO.
Methods:
We retrospectively reviewed 76 knees in 64 patients who underwent OWHTO between 2008 and 2019 at our institution. Cases combined with ACL reconstruction or with less than five years of follow-up were excluded. The mean follow-up period was 114.4 ± 36.4 months. The mean age at surgery was 61.7 ± 8.1 years. Radiographic assessments included mechanical proximal tibial angle (MPTA), joint-line obliquity (JLO), joint-line convergence angle (JLCA), and joint-space width (JSW) in medial (M1–M3) and lateral (L) compartments. The femoral and tibial osteophyte widths were also measured. Patients were divided into groups based on postoperative MPTA (≤95° or >95°) and JLO (<4° or ≥4°). Statistical analyses were performed using paired and unpaired t-tests.
Results:
Postoperatively, MPTA increased from 84.5° ± 2.2° to 94.1° ± 2.3°, and JLO decreased from 3.2° ± 1.3° to 2.1° ± 1.3°. At final follow-up, slight recurrence of varus alignment and mild OA progression were observed radiographically. Medial joint-space width (M1–M3) gradually decreased over time, while lateral joint-space width slightly increased. Although osteophyte width showed a trend of enlargement both in the femur and tibia, these changes were small in magnitude. Comparison between the high and low MPTA or JLO groups revealed no significant differences in OA progression parameters.
Discussion:
Previous biomechanical and clinical studies have suggested that excessive joint-line obliquity after OWHTO may increase shear stress, femoral condyle subluxation, and impingement of the intercondylar eminence. However, our results demonstrated that, even with mild increases in JLO, radiographic OA progression was limited at mid- to long-term follow-up. Although slight recurrence of varus alignment and gradual reduction in medial joint space were noted, these changes were modest and may not be clinically significant. The current findings support that moderate correction, aiming for a mechanical axis between 62.5% and 70% (%MA), provides stable alignment without accelerating lateral compartment degeneration. Nevertheless, continuous observation is warranted, as small degradative changes in the lateral cartilage may appear with longer follow-up

OS8-5



Tibial morphological variations reveal medial proximal tibial angle discrepancies in Japanese patients: three-type classification for high tibial osteotomy

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-Introduction/Purpose
In high tibial osteotomy (HTO), mechanical medial proximal tibial angle (mMPTA) measured on full-length radiographs is used for preoperative planning, while proximal anatomical MPTA (paMPTA) measured on limited fluoroscopic views is used for intraoperative verification. These measurements are traditionally assumed equivalent. However, Japanese patients exhibit distinct tibial morphology with complex deformities involving both proximal and distal segments. This study aimed to (1) characterize tibial morphology in Japanese patients with varus knee osteoarthritis, (2) quantify the relationship between mMPTA and paMPTA, and (3) provide morphology-specific correction factors for HTO.
-Material and Methods
This retrospective study analyzed 193 varus-aligned knees (hip-knee-ankle angle<0°) from 209 Japanese patients who underwent total knee arthroplasty or HTO between November 2019 and December 2020. Full-length lower limb radiographs were obtained within six months preoperatively. The tibia was divided into proximal, middle, and distal segments at one-third intervals along the anatomical axis. Anatomical axes were defined for each segment (proximal, middle, and distal anatomical axes). Proximal-middle (PM) and middle-distal (MD) angles were measured between consecutive segment axes. Nine morphological patterns were identified based on PM and MD angle combinations (varus<-1°, neutral -1° to 1°, valgus>1°) and consolidated into three clinically relevant types: medial bowing (proximal varus without distal compensatory valgus), straight (neutral or compensatory alignment), and lateral bowing (proximal valgus without distal compensation). The mMPTA was measured using the mechanical axis connecting the tibial plateau center to the talus center. The paMPTA was measured using the proximal anatomical axis. The difference (ΔMPTA=mMPTA-paMPTA) was calculated for each morphological type. Statistical analyses included Kruskal-Wallis test, chi-square test, paired t-tests, and one-way ANOVA with Scheffé post-hoc tests (significance $p<0.05$).
-Results
The cohort comprised 139 females and 54 males with mean age 70.9±10.2 years. Tibial deformities were highly prevalent: proximal deformities in 67.9% and distal deformities in 50.8% of knees. Among 193 knees, 49 (25.4%) were classified as medial bowing, 111 (57.5%) as straight type, and 33 (17.1%) as lateral bowing. No significant differences in patient demographics, Kellgren-Lawrence grades, or surgical procedure type existed among morphological types. Overall, mMPTA (84.5°±2.2°) and paMPTA (84.7°±1.8°) showed minimal discrepancy (ΔMPTA: -0.2°±1.2°, $p=0.03$). However, subgroup analysis revealed distinct patterns. The medial bowing type exhibited significantly lower mMPTA (82.9°±1.9°) than paMPTA (84.4°±1.9°), yielding negative ΔMPTA (-1.5°±0.5°, range -2.6° to -0.5°, $p<0.001$). The straight type showed nearly identical values (mMPTA: 84.9°±2.0°, paMPTA: 84.8°±1.8°, ΔMPTA: 0.0°±0.7°, range -1.9° to 1.4°, $p=0.60$). The lateral bowing type demonstrated higher mMPTA (85.8°±1.8°) than paMPTA (84.5°±1.8°), producing positive ΔMPTA (1.3°±1.0°, range 0.1° to 3.0°, $p<0.001$). These differences were statistically significant among the three morphological types ($p<0.001$).
-Conclusion
Japanese patients with varus knee osteoarthritis exhibit complex tibial morphologies involving both proximal and distal segments. In 42.5% of cases with non-straight tibial morphology, conventional assumptions of mMPTA-paMPTA equivalence may lead to measurement errors during HTO. The medial bowing type shows systematic under-measurement intraoperatively, while the lateral bowing type shows over-measurement. This three-type classification enables surgeons to identify at-risk patients and apply morphology-specific adjustments. Using mMPTA for preoperative planning and paMPTA for intraoperative verification with type-specific corrections may enhance surgical accuracy and improve clinical outcomes in HTO.

OS8-6

Investigation of Target Alignment in High Tibial Osteotomy According to the Severity of Osteoarthritis

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Purpose: To assess whether target alignment in high tibial osteotomy (HTO) should vary with osteoarthritis (OA) severity, we retrospectively analyzed outcomes using the Fujisawa point (62.5% WBL) as the standard.
Methods: 150 knees were grouped by postoperative alignment: under-correction (<55%), optimal (55–70%), and over-correction (≥70%). OA severity was classified by KL grade.
Results: Early OA patients in the over-correction group had poorer Forgotten Joint Scores. No significant differences were found in advanced OA.
Conclusion: For early OA, a WBL target near 60% is preferable.

OS9-1

Supine teleradiogram provides the most accurate preoperative planning for opening-wedge high tibial osteotomy: A comparative analysis of standing, supine, and supine valgus-stress imaging

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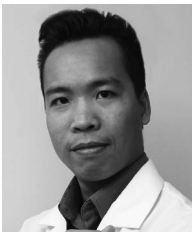
Introduction/Purpose
Accurate preoperative planning is essential for achieving intended correction in opening-wedge high tibial osteotomy (OWHTO). Although osteotomy changes bony alignment, postoperative leg alignment, including the hip–knee–ankle angle (HKAA) and weight-bearing line ratio (WBLR), is also influenced by soft-tissue laxity. Because soft-tissue tension differs under varus and valgus loading, the radiographic modality used for planning may differentially reflect postoperative soft-tissue behavior. Standing teleradiograms reflect varus-loaded lateral tightness and may not reflect the postoperative valgus condition, whereas supine imaging reduces weight-bearing effects. Supine valgus-stress teleradiograms were hypothesized to mimic the medial tension after valgus correction and thus better predict postoperative alignment. This study aimed to determine which preoperative imaging modality—standing, supine, or supine valgus-stress teleradiograms—most accurately predicts postoperative HKAA and WBLR when used for surgical planning.
Materials and Methods
Seventy-six consecutive OWHTOs performed from November 2019 to February 2025 with all three preoperative teleradiograms and a 1-year postoperative standing radiograph were retrospectively reviewed. The intraoperative correction angle was reconstructed using the pre- to postoperative change in medial proximal tibial angle (MPTA), and applied to each modality to calculate predicted postoperative alignment. Accuracy was assessed using mean absolute error (MAE), paired t-tests, and Wilcoxon tests. Subgroup analyses were performed according to postoperative alignment (HKAA ≥ 180° vs. < 180°). Predictors of planning error were explored using multivariate regression incorporating age, sex, BMI, preoperative JLCA, MPTA, and JLCA differences between modalities.
Results
Supine teleradiograms demonstrated no significant bias compared with actual postoperative WBLR (mean bias: 0.26%, P=0.805) and HKAA (-0.28°, P=0.191). In contrast, standing teleradiograms significantly underestimated the correction (WBLR bias: -10.06%, P<0.001; HKAA: -2.54°, P<0.001), while the supine valgus teleradiograms significantly overestimated it (WBLR bias: 16.70%, P<0.001; HKAA: 3.48°, P<0.001). The supine teleradiogram showed the lowest MAE for WBLR (6.65%, P<0.002) compared with standing (10.55%) and supine valgus teleradiograms (17.55%).
Subgroup analysis confirmed the superiority of the supine teleradiograms for both postoperative valgus (n=49) and varus (n=27) groups, with no significant WBLR bias (P = 1.000 for valgus, 0.603 for varus groups). Although the WBLR bias of the supine valgus views was smaller in the valgus group (14.67 ± 1.31%) than in the varus group (20.38 ± 3.74%), both remained greater than those of the supine view (0.88±1.30% for valgus; 2.32±1.77% for varus group).
There was no significant predictor of planning error for standing teleradiograms. For supine teleradiograms, lower preoperative MPTA was associated with overestimation (P = 0.017 for WBLR), with optimal values minimizing error of 84.3° for WBLR and 82.8° for HKAA. For supine valgus teleradiograms, younger age (P = 0.003) and larger JLCA differences across modalities (supine–standing P = 0.018; supine–valgus P = 0.001) contributed to overestimation.
Conclusion
Supine teleradiograms most accurately predicted postoperative HKAA and WBLR in OWHTO, demonstrating minimal error and no systematic bias. Contrary to the hypothesis that supine valgus-stress teleradiogram better reflects medial tension after valgus correction, it significantly overestimated the final correction. Meanwhile, standing teleradiograms consistently underestimated the correction. The findings suggest that postoperative soft-tissue behavior is best approximated by the reduced weight-bearing conditions of the supine position. Therefore, supine teleradiograms should be considered the most reliable modality for OWHTO planning.

OS9-2



Predicting the Correction Angle in Medial Open-Wedge High Tibial Osteotomies: The Role of Preoperative Medial Proximal Tibial Angle

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Introduction: Medial open-wedge high tibial osteotomy (MOWHTO) is performed to correct varus deformity and redistribute mechanical load in patients with medial compartment osteoarthritis. Although the medial proximal tibial angle (MPTA) influences the required correction angle, its relationship with the degree of correction remains underexplored. Furthermore, current planning methods can be time-consuming or require specialized software, highlighting the need for simple and reliable predictive tools.
This study aimed to evaluate the correlation between lower limb alignment parameters—particularly preoperative MPTA—and the correction angle, as well as to assess the clinical utility of MPTA-based conversion formulas.
Material and Methods: From January 2016 to December 2024, 205 varus-aligned knees and medial compartment osteoarthritis undergoing MOWHTO were included. Using standing whole-leg radiographs, a MOWHTO simulation was performed to determine the correction angle required to achieve a postoperative MPTA of 93°. 205 knees were divided into a simulation group for correlation analysis and development of the conversion formulas (176 knees), and a validation group, where postoperative MPTA was maintained from 92° to 94° (±1° from the target) (29 knees), to compare the correction angle calculated from conversion formulas and measured in the digital software. Correlation and regression analyses evaluate relationships, while paired t-test and Wilcoxon signed-rank tests assessed conversion formulas accuracy.
Results: The correction angle, defined as the angle required to align the WBL percentage to its ideal position, demonstrated a near-perfect linear correlation with the pre-MPTA, change in (Δ) MPTA, ΔHKA angle, and ΔWBL pct (|r| = 0.90 – 0.99, $P < 0.01$). The correction angle showed perfect linear correlations with pre-MPTA (y = 95.8 - 1.03x, R_adj^2= 1.00), ΔHKA angle (y = 0.0307 + 1.03x, R_adj^2= 1.00), ΔWBL percentage (y = 0.416 + 0.223x, R_adj^2= 0.94), ΔMPTA (y = -0.0101 + 1.03x, R_adj^2= 1.00). Calculated values closely matched postoperative outcomes, with no significant differences observed, demonstrating high consistency and reliability of the conversion formulas. The mean error between the correction angle derived from the conversion formulas and that obtained using digital planning software ranged from 0.2° (95% CI: -0.1 – 0.4°), confirming the accuracy and clinical applicability of the conversion formulas.
Conclusions: The correction angle was perfectly correlated with pre-MPTA, ΔHKA angle, ΔWBL percentage, and ΔMPTA, suggesting that these parameters may serve as reliable predictors during preoperative planning. The derived conversion formulas can be effectively applied in clinical practice to accurately calculate the required correction angle for MOWHTO.
Keywords: medial open wedge; high tibial osteotomy; medial proximal tibial angle; correction angle; correlation

OS9-3

Three-dimensional dynamic alignment analysis during gait following high tibial osteotomy using a 3D gait and alignment measurement system

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-Introduction/Purpose
High tibial osteotomy (HTO) corrects lower limb alignment toward valgus, thereby shifting the mechanical axis laterally to reduce medial knee joint stress. In addition to achieving appropriate static alignment as assessed by radiographs, evaluation of dynamic alignment during gait is important for obtaining favorable postoperative outcomes. However, few studies have investigated dynamic lower limb alignment after HTO. This study aimed to analyze the femoral and tibial axes and overall lower limb alignment during the stance phase of gait after HTO.
-Material and Methods
Four patients (five knees; mean age 60.4 years) who underwent hybrid closed-wedge HTO (HCWHTO) were analyzed. A three-dimensional gait analysis system (VICON) was combined with a three-dimensional alignment measurement system (KneeCAS) using a 2D–3D image-matching technique to evaluate femoral and tibial kinematics.
In this study, valgus inclination of the femur or tibia was defined as a positive coronal tilt of each mechanical axis relative to the ground, whereas varus inclination was defined as negative.
The coronal plane angular displacement of the femoral axis, tibial axis, and hip–knee–ankle (HKA) angle during the stance phase was assessed.
-Results
The mean angles of the femoral axis, tibial axis, and HKA during the loading response/mid-stance/terminal stance phases were 4.2° valgus / 4.9° valgus / 4.8° valgus for the femur, 1.6° varus / 0.2° valgus / 0° neutral for the tibia, and 5.9° valgus / 4.6° valgus / 4.8° valgus for the HKA, respectively. The corresponding angular displacements were 1.6° valgus / 0.2° valgus / 0.9° varus for the femur, 2.2° valgus / 0.9° valgus / 0.7° varus for the tibia, and 0.7° varus / 1.0° varus / 0.3° varus for the HKA.
-Conclusion
In patients after HCWHTO, valgus inclination of the tibia and a corresponding varus shift in overall limb alignment were observed from the loading response to mid-stance. The degree of tibial angular displacement was comparable to that reported in patients with varus-type osteoarthritis analyzed using the same technique. These findings suggest that although postoperative alignment is corrected to valgus at initial contact, a gradual varus shift occurs toward mid-stance. The magnitude of this shift may be predictable from preoperative gait analysis, potentially aiding in determining the optimal correction angle and target alignment during surgery.

OS9-4

Evaluation of the indication and postoperative optimal alignment of opening-wedge high tibial osteotomy by preoperative joint line convergence angle

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Introduction/Purpose: Recently, the number of opening-wedge high tibial osteotomy (OWHTO) has increased for early knee osteoarthritis (OA) with Kellgren-Lawrence (KL) grades 0-2, and optimal alignment of OWHTO for early knee OA remains controversial. The aim of this study was to evaluate the related factors to postoperative cartilage improvement and patient-reported outcome measures (PROMs) after OWHTO with a particular focus on joint line convergence angle (JLCA) and hip-knee-ankle angle (HKAA).
Material and Methods: A total of 135 knees underwent OWHTO and second-look arthroscopy. The mean (SD) follow-up period was 5.3 (2.7) years. Preoperative (pre) and postoperative (post) KL grade, weight-bearing line ratio (WBLR), HKAA, mechanical lateral distal femoral angle, medial proximal tibial angle, and JLCA were measured radiographically. The International Cartilage Repair Society (ICRS) grades in the medial femoral condyle (MFC) and the medial tibial plateau (MTP) were evaluated during the initial and second-look arthroscopy. The cartilage status in the medial femorotibial joint (MFT) was evaluated by adding the ICRS grades of the MFC and MTP. A case with cartilage improvement in the MFT, classified as the MFT-I, was defined as a negative value obtained by dividing the ICRS grade at the second look from the initial ICRS grade. Others are classified as the non-MFT-I. The correlations between KL grade, JLCA, and HKAA were analyzed using Spearman's correlation test. Demographic data, radiographic parameters, cartilage status, and KOOS scores at final follow-up were compared between the MFT-I and non-MFT-I groups using the Mann-Whitney U test and chi-square test. The pre- and post-related factors to MFT-I were evaluated by logistic regression analyses. All statistical data were presented as medians [interquartile ranges].
Results: MFT-I was detected in 63 knees (46.7%), and non-MFT-I was observed in 72 knees (53.3%). Pre-JLCA was significantly correlated with pre-KL grade ($R = 0.765$, $p < 0.001$), and the median JLCA values for KL grades 1 to 4 were 0.8 [0.5 - 1.4] °, 1.8 [1.5 - 2.6] °, 3.7 [2.8 - 5.0] °, and 5.4 [4.9 - 6.5] °, respectively. In the comparison of radiographic parameters, median pre- (1.9 [1.0 - 2.6] °) and post-JLCA values (1.3 [0.7 - 1.9] °) in the MFT-I group were significantly smaller than in the non-MFT-I group (2.9 [1.8 - 3.9] ° and 2.0 [1.1 - 2.6] °, $p < 0.001$ and $p = 0.005$, respectively), and median post-HKAA value (-2.1 [-3.4 - -0.8] °) in the MFT-I group was significantly smaller than that of the non-MFT-I group (-1.0 [-2.2 – 0.2] °, $p = 0.008$). In addition, the logistic regression analysis showed pre-JLCA was significantly associated with MFC-I ($p < 0.001$), and the receiver operating characteristic (ROC) analysis calculated a cutoff value of 2.6° ($p = 0.008$). Furthermore, post-HKAA was also significantly associated with MFC-I ($p = 0.020$), and the ROC analysis calculated a cutoff value of -1.4° ($p = 0.006$). Similarly, post-WBLR was significantly associated with MFT-I with a cutoff value of 55.4% ($p = 0.002$). Finally, median scores of KOOS symptoms, pain, activities of daily living (ADL), sports activity, and quality of life (QOL) in the MFT-I group were significantly higher than those of the non-MFT-I group ($p = 0.007$, 0.002, 0.004, 0.028, and 0.006, respectively.
Conclusions: Pre-JLCA < 2.6°, post-HKAA < -1.4°, and post-WBLR > 55.4% were associated with cartilage improvement in medial compartment of the knee that related to favorable PROMs after OWHTO. In cases with pre-KL 0-1 or pre-JLCA < 2.6° in KL 2-3, the optimal alignment after OWHTO should be WBLR ≥ 55%. In contrast, in cases with pre-JLCA ≥ 2.6° in KL 2-3 or KL 4, the optimal alignment after OWHTO should be WBLR ≥ 62.5%.

OS9-5

Detection of Lateral Hinge Fractures After Medial Closing Wedge Distal Femoral Osteotomy: Computed Tomography Versus Plain Radiography

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-Introduction/Purpose Limited evidence exists in the literature regarding the detection rates of lateral hinge fracture (LHF) on computed tomography (CT) after medial closing wedge distal femoral osteotomy (MCDFO). Moreover, the effect of LHF on bone healing after MCDFO remains unclear. The purposes of this study were (1) to investigate the detection rates of LHF as shown on plain radiography and CT after MCDFO and (2) to compare the incidence of problematic bone healing between knees with LHF and those without LHF. -Material and Methods Patients who underwent MCDFO between May 2009 and July 2019 were retrospectively evaluated. The presence of LHF was evaluated using immediate postoperative plain radiography and CT. The detection rates of LHF on plain radiography and CT were compared. The incidence of problematic bone healing (nonunion, delayed union, and loss of correction) was also compared between the knees with LHF and those without LHF. -Results A total of 55 knees of 43 patients (mean age, 37.7 6 16.7 years) were included in the study. Although 33 LHFs were detected on CT, only 19 LHFs were detected on plain radiography. The detection rate of LHF was significantly higher on CT than on plain radiography (60% vs 34.5%; P = .008). At 1-year follow-up, 10 cases of problematic bone healing (1 nonunion, 4 delayed unions, and 5 losses of correction) were identified. The incidence of problematic bone healing was significantly higher in the knees with LHF than in those without LHF as shown on plain radiography (36.8% vs 8.3%; P = .001) and CT (30.3% vs 0%; P = .004). -Conclusion LHF can be detected better on CT than on plain radiography and has a negative effect on bone healing after MCDFO. For patients with LHF detected on either plain radiography or CT, careful rehabilitation with close follow-up is recommended.

Oral Presentation 10 AKO operative technique

OS10-1

Biomechanical Evaluation of a Newly Designed Locking Plate for Opening-Wedge High Tibial Osteotomy: Stress Around D-hole in the Presence of Lateral Hinge Fracture

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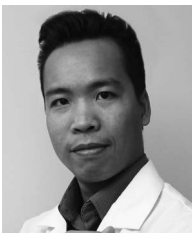
-Introduction/Purpose
This study aimed to evaluate whether the newly designed OhtoFix locking plate reduced stress around the D-hole compared to the old OhtoFix and TomoFix plates. Additionally, we sought to determine whether the new OhtoFix plate maintained its biomechanical stability in the presence of a lateral hinge fracture (LHF).
-Material and Methods
A finite element (FE) model of the proximal tibia was developed using cross-sectional images from a 62-year-old Asian female. The model simulated opening-wedge high tibial osteotomy (OWHTO) with three different locking plates: the old and new OhtoFix plates, and the TomoFix plate. The peak von Mises stress (PVMS) around the D-hole and across the entire plate was analyzed to assess the biomechanical performance of the three plates.
-Results
The newly designed OhtoFix plate demonstrated lower stress around the D-hole compared with both the old OhtoFix and TomoFix plates. The PVMS around the D-hole was 189.5 MPa in the new OhtoFix plate, 251.5 MPa in the old OhtoFix plate, and 233.3 MPa in the TomoFix plate. Although the new plate showed a reduction in PVMS across the entire plate compared to the old OhtoFix, it did not surpass the TomoFix. Even in the presence of an LHF, the new OhtoFix plate showed lower stress around the D-hole compared with the old OhtoFix and TomoFix plates. The highest stress was observed with a type II LHF, with PVMS values of 218.1 MPa, 310.4 MPa, and 267.0 MPa in the new OhtoFix, old OhtoFix, and TomoFix plates, respectively. However
-Conclusion
The newly designed OhtoFix plate provided improved stress distribution around the D-hole, even in the presence of an LHF, compared to the old OhtoFix and TomoFix plates. However, although it reduced peak stress around the D-hole, it did not surpass the TomoFix plate in overall stress performance across the entire plate.

OS10-2



Patient-Specific Instrumentation for Medial Open Wedge High Tibial Osteotomy Results in High Accuracy of Correction and Cartilage Regeneration: A Second Look Arthroscopy Study

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Introduction: Medial open-wedge high tibial osteotomy (MOWHTO) is an effective surgical treatment for medial compartment degenerative osteoarthritis of the knee with varus deformity. However, both preoperative planning and intraoperative execution remain challenging due to the limitations of two-dimensional radiographic assessment and variability in limb positioning, including the non–weight-bearing condition during surgery, which may affect correction accuracy.
To overcome these limitations, patient-specific instrumentation (PSI) utilizing the extraosseous verification method and three-dimensional imaging techniques has been introduced. Although PSI has been reported to achieve high accuracy and low complication rates in MOWHTO for medial compartment osteoarthritis, few studies have specifically investigated its precision in MPTA-based planning, its impact on clinical outcomes, and the condition of knee joint cartilage under arthroscopic evaluation following MOWHTO.
The purpose of this study was to evaluate the precision of PSI in MPTA-based MOWHTO and to assess cartilage regeneration and clinical outcomes.
Material and Methods: From August 2018 to December 2022, patients undergoing PSI-guided MPTA- based MOWHTO were included, with a minimum follow-up period of 2 years. Exclusion criteria included MOWHTO without PSI, surgical planning not based on MPTA, bilateral knee surgery, procedure changes during surgery, and loss of follow-up. Accuracy was classified into three categories: high, acceptable and low accuracy based on the correction error (≤1°, 1°–2°, and >2°, respectively). Paired-sample t-tests compared preoperative and postoperative alignment and clinical scores, while rank sum and Fisher's exact tests assessed arthroscopic findings.
Results: Radiological and clinical assessments were conducted on 39 patients. Cartilage regeneration was assessed by arthroscopy in 30 knees during implant removal. The error between preoperative planning and postoperative MPTA was at 0.1° ± 1.7° (95% CI: -0.5 – 0.6). The number of knees having the high, acceptable and low accuracy was 21 (54%), 9 (23%) and 9 (23%) (p-value = 0.03) respectively. No significant changes were observed in posterior tibial slope. The KOOS showed a significant improvement after surgery compared to the preoperative score, from 47 ± 18 to 74 ± 14 with 100% patients exceeding the threshold for minimal clinically important difference. The mean weight-bearing line percentage significantly improved 19.5% ± 10.1% to 59.0% ± 7.3%, and the mean MPTA was corrected from 84.7°± 1.8° preoperatively to 92.6° ± 2.1° postoperatively. A second-look arthroscopy revealed significant cartilage regeneration on the medial femoral condyle surfaces.
Conclusions: The use of PSI in MPTA-based MOWHTO resulted in highly and acceptably accurate correction in the majority of cases, preservation of the PTS, and improved clinical outcomes in all patients. Furthermore, MOWHTO promotes cartilage regeneration at MFC following a 2-year follow-up.
Keywords: Patient-specific instrumentation, High tibial osteotomy, Open wedge, Medial proximal tibial angle, Cartilage Regeneration, Accuracy.

OS10-3

Anterior popliteus transtibial tuberosity osteotomy: a novel technique for knee osteoarthritis

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Purpose: to establish a novel surgical technique which is anterior popliteus transtibial tuberosity osteotomy (APTTO) based on anatomy and three-dimensional finite element analysis, verify its safety and clinical efficacy.
Material and Methods: based on imaging studies, intraoperative research on the patellar tendon insertion, and anatomical specimen validation, the tibial tuberosity was divided into zones to create the APTTO. This was compared with the existing biplane high tibial osteotomy. Characteristics such as anatomical relationships, patellar height, interference with collateral ligaments, vascular protection, and the hinge compression mechanism were observed. Finite element analysis and classical mechanical testing were performed to observe the mechanical properties and stress distribution of internal fixation across different techniques. A retrospective analysis was conducted on clinical data from 125 patients with knee osteoarthritis treated with APTTO, including 36 males and 89 females, aged 45-92 years, with a disease duration of 12-90 months. Preoperative and final follow-up measurements were compared for FTA, MPTA, WBL, CDI, JLCA, VAS score and KSS score, and surgical complications.
Results: the tibial tuberosity could be evenly divided into four zones: A, B, C, and D. The effective insertion of the patellar tendon was located only in zones A and B. The APTTO osteotomy line was set at the junction of zones B and C. Compared to other techniques, the APTTO osteotomy line is completely covered by the popliteus muscle, does not cause patella baja, and does not disrupt the integrity of the medial collateral ligament or the pes anserinus. Under mechanical conditions simulating standing, sit-to-stand transition, and maximum stress during walking, the APTTO resulted in the smallest maximum axial displacement of the tibial plateau. APTTO also demonstrated the most favorable maximum equivalent stress on the screws ($P < 0.05$). Patient follow-up ranged from 22 to 42 months, with an average of (26.6 ± 3.4) months. No complications such as popliteal neurovascular injury, patella baja, type III hinge fracture, or non-union occurred in any patient. The average surgical time was (38 ± 12) minutes. Three patients had superficial infections, one had a deep infection, five had incision healing impairment, and three had type II hinge fractures. At the final follow-up, FTA changed from varus 9.6° ± 2.9° to valgus 2.4° ± 2.1°, MPTA increased from 79.4° ± 3.1° to 91.5° ± 2.4°, WBL percentage increased from 11.6% ± 13.5% to 60.8% ± 9.3%, JLCA decreased from 4.3° ± 1.7° to 2.3° ± 1.1°, VAS score decreased from 4.9 ± 2.2 points to 1.2 ± 0.8 points, and the KSS knee score increased from 45.2 ± 12.3 points to 87.7 ± 5.3 points. All these improvements were statistically significant ($P < 0.05$). The CDI showed no statistically significant difference compared to the preoperative value ($P > 0.05$). The maximum knee flexion reached 160° in patients with unilateral surgery and 156° in those with bilateral surgery. The length of the percutaneous minimally invasive incision was 2.5 ± 0.5 cm.
Conclusion: the APTTO can effectively correct lower limb varus deformity in patients with severe varus knee osteoarthritis. It significantly alleviates pain, improves knee function, and effectively avoids complications such as popliteal neurovascular injury, patella baja, insufficient or excessive release of the medial collateral ligament, and type III hinge fractures.

OS10-4

Clinical Significance of an Additional Crossed Screw in Medial Opening-Wedge High Tibial Osteotomy

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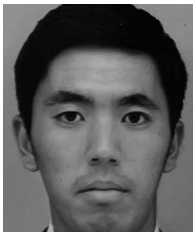
Introduction
Opening-wedge high tibial osteotomy (OWHTO) has been reported to provide favorable outcomes as a surgical treatment for medial compartment knee osteoarthritis. Maintenance of lower-limb alignment is essential for achieving long-term success, and stable plate fixation combined with bone graft materials of the opening gap generally yields satisfactory results. However, postoperative complications such as delayed bone union, lateral hinge fractures, and loss of correction still occur, indicating the need for more reliable initial mechanical stability. To address this issue, our department introduced an additional crossed screw technique in September 2024 to enhance stability at the osteotomy gap. The present study evaluated its clinical significance based on short-term outcomes.
Purpose
To evaluate the short-term effects of an additional crossed screw in OWHTO on bone union and postoperative alignment stability.
Methods
Patients who underwent OWHTO between 2021 and 2025 and completed postoperative three-month CT follow-up were included. They were divided into two groups: those with an additional crossed screw (Group A, n = 11) and those without (Group N, n = 23). Evaluation items included BMI, intraoperative opening gap size, and mechanical alignment measured by MPTA on plain radiographs obtained preoperatively, immediately postoperatively, and at two months. Pain at time of discharge was assessed using the visual analog scale (VAS). Bone union was evaluated using the van Hemert classification. Three-month CT images were analyzed by dividing the coronal osteotomy gap into five equal sections and grading artificial bone resorption in three stages. In addition, sagittal CT images were used to score posterior cortical continuity and the presence of excessive callus formation.
Results
The intraoperative opening gap was significantly larger in Group A than in Group N ($p = 0.035$). No loss of correction was observed in Group A ($p = 0.341$), whereas Group N showed an average correction loss of 0.4° ($p = 0.047$). Posterior cortical scoring on sagittal CT was significantly higher in Group A ($p = 0.042$). In contrast, no significant differences were found between groups in the van Hemert classification, VAS, BMI, or artificial bone resorption.
Discussion
The addition of a crossed screw may facilitate preservation of posterior cortical continuity even in cases requiring larger correction angles, thereby contributing to improved initial fixation stability. The technique requires no additional skin incision and can be performed with relative ease, which represents another advantage. No adverse events related to the crossed-screw technique have been observed to date. These findings suggest that the technique may serve as a useful adjunct to enhance stability in OWHTO.
Conclusion
The addition of a crossed screw may improve initial mechanical stability in OWHTO and contribute to favorable bone union and maintenance of correction. Further studies with a larger number of cases and long-term follow-up will be necessary to validate these findings.

OS10-5



Mid-term Results of ACL Reconstruction Combined with Medial Wedge-Opening High Tibial Osteotomy (OWHTO) for Post-Traumatic Osteoarthritis following ACL injury

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Introduction/Purpose

Anterior cruciate ligament (ACL) deficient knee leads to the development of knee osteoarthritis and progressive tibiofemoral varus alignment. The optimal surgical treatment for Post-Traumatic Osteoarthritis following ACL injury remains unclear. Reports of ACL Reconstruction (ACLR) combined with Medial Wedge-Opening High Tibial Osteotomy (OWHTO) remain scarce in Japan.

We evaluate the postoperative outcomes of ACLR combined with OWHTO for Post-Traumatic Osteoarthritis following ACL injury

Material and Methods

This study included 12 knees treated at our hospital with at least one year of follow-up. ACLR combined with OWHTO for Post-Traumatic Osteoarthritis following ACL injury. We select ACLR combined with OWHTO for the patients who have the symptoms of knee instability and medial pain. Considering the temporal and social aspects, it is being conducted simultaneously. X-ray alignment measurements (% Mechanical axis (%MA), Medial proximal tibial angle (MPTA), Lateral distal femoral angle (LDFA), Joint line convergence angle (JLCA), anterior tibial translation (ATT), K-L grade, medial joint space (MJS)) and Knee injury and Osteoarthritis Outcome Score (KOOS) were compared preoperatively and at final follow-up. Knee flexion/extension strength was assessed by using Easy Tech.

Results

The mean follow-up period was 3.1 ± 1.5 years. %MA improved from 21.9% to 59.6%, MPTA increased from 86.0 to 92.5 degrees, and KOOS scores (59.2/61.6/75.7/35.4/30.8 → 86.9/94.4/95.6/80.8/75.3) showed significant improvement in symptoms, pain, QOL. Knee flexion/extension strength (flexion 105.2→185.5, extension 50.1→101.8 Nm/%BW) were significantly higher at final follow-up ($p<.05$). Second-look arthroscopy showed no ACL laxity in 8/10 knees, and no cases has worsened K-L grade.

Conclusions

We reported the mid-term outcomes of ACLR combined with OWHTO for Post-Traumatic Osteoarthritis following ACL injury. By performing simultaneously, the treatment period was shortened, and favorable results were obtained in clinical scores and muscle strength.

When performing ACLR combined with OWHTO, care should be taken to avoid increasing PTS by thickening the posterior artificial bone. ACLR combined with OWHTO is considered useful for correcting alignment and achieving knee stability.

OS10-6

Uniplanar Open Wedge High Tibial Osteotomy : Surgical Techniques

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-Introduction/Purpose

Open wedge high tibial osteotomy (OWHTO) has been recognized as a beneficial treatment for osteoarthritis of the medial compartment arthritis of the knee. Then, several different osteotomy, gap filling and fixation techniques are introduced by each different author. The purpose of this study is to introduce author's unique surgical techniques for uniplanar OWHTO.

-Material and Methods

From March 2013 to November 2025, one thousand three hundreds thirty five consecutive uniplanar OWHTO were done. Through medial oblique surgical incision and proximal oblique osteotomy was done by custom made osteotomies after multiple pre-drilling by 2.5 mm drill bite without using saw blade. Wedge shaped gap in osteotomy site was filled with calcium-sulfate blocks in all cases. Osteotomy was fixated by three different locking plate and screw systems using minimally invasive techniques. Medial deep soft tissue repair was done and plate and screws were covered completely by soft tissue at deep fascia level.

-Results

There were no neurovascular injuries in 1,335 consecutive uniplanar OWHTO. Twenty cases of hinge breakage were found but no revision surgery was followed. Two cases of superficial wound infection with skin disruption were found and which were controlled by second look debridement and suture without removal of initially fixed hardware.

-Conclusion

In OWHTO, combination of osteotomy after multiple pre-drilling, calcium sulfate block and meticulous soft tissue repair guaranteed good results with low complication rate.

Oral Presentation 11 AKO infection

OS11-1

Infection Risk Following Medial Open-Wedge High Tibial Osteotomy: Does the Type of Artificial Bone Graft Matter?

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Introduction
Medial Open Wedge High Tibial Osteotomy is a joint-preserving procedure used to treat isolated medial compartment osteoarthritis. Multiple cohorts revealed bone allograft as a risk factor for surgical site infection (SSI) but no study conducted detail analysis. We aimed to clarify the influence of different types of artificial bone graft on the infection rate.
Method
This retrospective study included patients who underwent MOWHTO with artificial bone graft (Tricalcium phosphate or Calcium sulfate for isolated medial compartment osteoarthritis with genu varum from single-surgeon, two tertiary referral hospitals between November 2016 and September 2023. Potential risk factors including type of artificial bone graft, sex, age, body mass index (BMI), underlying disease, hospitalization length, correction angle, and surgery time were analyzed via both univariate and multivariate analysis.
Result
Among 119 patients who underwent 121 procedures (60 of TCP; 61 of CS), 13 (10.7%%) developed SSI and 4 (3.3%) developed deep SSI. Univariate analysis showed that smoking, hospital stay, and Calcium sulfate usage were associated higher SSI incidences. In multivariate analysis, SSI was positively associated with diabetes mellites and use of Calcium sulfate.
Conclusions
In conclusion, calcium sulfate as a bone substitute heightened the risk of SSI relative to tricalcium phosphate in MOWHTO, with diabetes mellitus recognized as an independent risk factor.

OS11-2

Olanexidine gluconate versus povidone-iodine for the prevention of surgical-site infection in osteotomy around the knee: a retrospective study

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-Introduction/Purpose
Olanexidine gluconate (OLG) is a recently developed skin antiseptic with broad-spectrum activity, including efficacy against methicillin-resistant Staphylococcus aureus and vancomycin-resistant Enterococcus. This study aimed to evaluate the clinical effectiveness and safety of OLG in preventing surgical-site infection (SSI) following osteotomy around the knee (AKO).
-Material and Methods
We retrospectively reviewed 469 knees in 405 patients who underwent AKO between March 2017 and December 2024. Patients were divided into two groups: 157 knees in 141 patients treated with OLG between September 2022 and December 2024 (OLG group), and 312 knees in 264 patients treated with povidone-iodine (PVP-I) between March 2017 and August 2022 (PVP-I group). Outcomes were defined as the incidence of superficial SSI within 30 days, deep SSI within 1 year, and adverse skin reactions. In addition, univariate and multivariate analysis were used to identify the independent predictors of SSI.
-Results
Deep SSI was significantly reduced in the OLG group (0.0% vs. 2.9%; p=0.032), while rates of superficial SSI were not significantly different (0.6% vs. 1.0%; p=0.718). No adverse skin reactions were reported in either group. Multivariate analysis identified male sex (odds ratio [OR] 13.8, 95% CI 1.47–129.5; p=0.022) and corticosteroid use (OR 72.9, 95% CI 2.93–1813; p=0.009) as independent predictors of SSI.
-Conclusion
This retrospective study demonstrated that OLG significantly reduced the incidence of deep SSI after AKO compared with PVP-I in univariate analysis. However, OLG did not remain an independent predictor in multivariate analysis. These findings suggest OLG may be a safe and effective alternative for infection prophylaxis in knee osteotomy, though further prospective studies are warranted.

OS11-3

One-Year Outcome of Postoperative Infection after Knee Osteotomy

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[Introduction]
Infection is one of the most common postoperative complications of high tibial osteotomy (HTO). Some reports suggest that deep infection occurs in 0.5% to 7% of cases, but the postoperative outcome of such infections remains unclear. The purpose of this study was to review the treatment and outcomes of deep infection as experienced at our hospital.
[Subjects and Methods]
124 knees that underwent open wedge high tibial osteotomy (OWHTO) or hybrid closed wedge high tibial osteotomy (H-CWHTO) and could be followed up at least one year after surgery were included in the study. The outcomes included postoperative infection rate, time of onset, organisms causing the infection, treatment, and results.
[Results]
Deep infection occurred in 4 knees (3.2%), OWHTO in 3 knees (4.6%), and CWHTO in 1 knee (1.7%). The mean time of infection was 98 days, with 3 cases of MSSA and 1 case of MRSA. All patients underwent early debridement and did not require hardware removal until bone fusion. At 1 year postoperatively, knee range of motion was good in all patients, and KOOS and JOA were also good. In addition, there was no difference in results at 1 year postoperatively between the infected and uninfected groups.

OS12-1

Gap Volume Based on CT Measurement Is a Strong Risk Factor for Delayed Gap Healing After OWHTO

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-Introduction/Purpose
To identify factors that affect delayed gap healing after open-wedge high tibial osteotomy (OWHTO), and to determine whether large gap volume is a predictor of delayed gap healing.
-Material and Methods
This retrospective study analyzed biplane OWHTO performed between 2019 and 2023 for knee osteoarthritis or osteonecrosis. The minimum follow-up was 1 year. Delayed gap healing was defined as when the medial half of the osteotomy gap area had not reached the consolidation phase by 6 months after surgery based on anteroposterior knee radiographs. Gap volume was calculated from computed tomography images. Logistic regression was performed using body height, smoking, correction angle, hinge fracture, flange thickness, and gap volume. A gap volume cutoff value for delayed gap healing was determined with receiver operating characteristic curve analysis. Gap volume was predicted with multiple linear regression.
-Results
There were 80 knees in 71 patients (36 men and 44 women). The mean gap volume was 7.6 cm3. Gap healing rates at 3, 6, 9, and 12 months after surgery were 26%, 65%, 89%, and 100%, respectively. There were 25 knees with delayed gap healing. Male sex was not a significant risk factor when adjusted for body height. Multivariate logistic regression revealed that only larger gap volume was a significant risk factor (odds ratio, 1.45; P = .006). The gap volume cutoff value was 7.6 cm3, with an area under the curve of 0.74. Tall body height and a large correction angle (both P < .001) were associated with a significantly larger gap volume (R2 = 0.73).
-Conclusion
Large gap volume is the most important risk factor for delayed gap healing after OWHTO. Gap volume can be predicted based on body height and correction angle. When OWHTO with substantial correction is planned for a tall man, surgeons should be aware of possibly delayed gap healing.

OS12-2

Trial to Promote Bone Healing by Highly Osteoinductive Artificial Bone in MOWDTO

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4)Hommachi N clinic, 5)Department of Orthopedic Surgery, Tamai Hospital, Japan

Introduction/Purpose: We compared the bone healing promotion effects of filling the lateral aspect of the osteotomy site with an artificial bone material possessing high osteoconductive properties.
Material and Methods: The study included 66 knees (mean age 60.6 ± 8.5 years) treated with MOWDTO. All cases involved insertion of a 1.0 cm wedge-shaped Osferion 60® into the medial margin of the osteotomy site. Patients were divided into a R group (n=34 knees) where artificial bone was packed into the lateral osteotomy margin and a N group (n=32 knees) where it was not packed. CT scans of the knee joint were performed at 3, 6, and 12 months postoperatively. The presence or absence of bone union in Brosset classification zone 3 was assessed, and the proportion of union was compared between groups. Additionally, hinge length, flange thickness, and flange length of the osteotomy site were also compared.
Results: The union rate at 3 and 6 months postoperatively showed a significantly higher in the R group ($p<0.05$). However, at 12 months postoperatively, the rate showed no significant difference between the two groups. Furthermore, no significant differences were observed between the two groups in hinge length, flange thickness, or flange length.
Conclusion: Filling the osteotomy site with an artificial bone material possessing high osteoconductive properties during MOWDTO accelerated postoperative bone union.

OS12-3

Bicortical Distal Screw Fixation Enhances Union and Reduces Correction Loss in Medial Open-Wedge High Tibial Osteotomy

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Introduction: In medial opening-wedge high tibial osteotomy (MOWHTO), monocortical distal screw fixation is often selected to lower the risk of contralateral neurovascular injury during drilling. However, whether the distal screw configuration itself influences biological gap union and the maintenance of coronal correction remains unclear. To address this practical question within a single implant platform (TriS plate), we compared early union and loss of medial proximal tibial angle (MPTA) correction between monocortical and fully bicortical distal fixation, and we explored clinical and surgical factors associated with correction loss using multivariable modeling.
Methods: We retrospectively reviewed consecutive MOWHTO procedures performed with a TriS plate at our institution from January 2019 to February 2024. After excluding cases with rheumatoid arthritis and incomplete data, 81 patients (87 knees) with ≥12 months of follow-up were eligible for analysis. Two distal fixation configurations were evaluated: Group A, monocortical fixation for the two most distal screws; Group B, bicortical fixation for all four distal screws. To mitigate over-penetration and potential contralateral injury in Group B, surgeons used a novel stopper-equipped drill that limits drilling depth in a controlled manner. Standardized perioperative protocols and rehabilitation were applied throughout the study period. Bone union at 3 and 6 months was assessed on routine anteroposterior radiographs according to institutional criteria for bridging callus and cortical continuity across the opening gap. Maintenance of coronal alignment was quantified as the change in MPTA from immediately postoperative to 12 months; greater absolute change indicated greater loss of correction. Group comparisons used Student's t test and χ^2 test. Multiple linear regression examined predictors of MPTA correction loss, entering fixation method, opening width, BMI, and presence of a hinge fracture as covariates. Statistical significance was defined as $P < 0.05$.
Results: Baseline demographics and preoperative radiographic parameters were similar between groups. Union at 3 months was achieved in 23% of Group A versus 64% of Group B ($P = 0.0002$). At 6 months, union rates were 71% and 89%, respectively, demonstrating a continued trend favoring the bicortical configuration. At 12 months, mean MPTA loss was 0.6° ± 0.6° in Group A and 0.1° ± 0.2° in Group B, indicating significantly smaller—and less variable—loss of correction with four bicortical distal screws ($P < 0.0001$). A loss ≥1° occurred in 23% of Group A compared with 2% of Group B. In multivariable analysis, four-screw bicortical fixation independently predicted reduced MPTA loss after adjustment for opening width, BMI, and hinge fracture. No neurovascular injuries were observed when the stopper-equipped drill was used.
Conclusion: Although prior finite-element work has suggested minimal differences in mechanical strength between distal fixation strategies, the present clinical series indicates that bicortical fixation of all four distal screws promotes earlier gap healing and better preserves coronal alignment after MOWHTO. When combined with depth-limiting drilling to control far-cortex penetration, fully bicortical distal fixation appears to be a safe and effective option to enhance biological union and maintain correction. Prospective studies are warranted to confirm these findings and to refine indications for each distal fixation strategy within contemporary plate systems.

OS12-4

Early Completion of Radiographic Bone Union with Rare Complications After Inverted V-shaped HTO Fixed with a Locking Compression Plate

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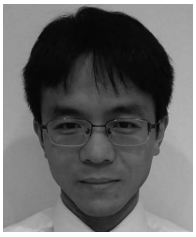
BACKGROUND: Inverted V-shaped (iV) high tibial osteotomy (HTO) procedure is defined as a hemi-lateral closing wedge and hemi-medial opening wedge HTO procedure with immediate bone grafting. The iVHTO is classified as a neutral wedge HTO. Recently, the iVHTO procedure fixed with a locking compression plate (LCP) has attracted notice as a useful surgical option for the medial osteoarthritic knees with severe varus deformity, because various advantages compared with other HTO procedures have been demonstrated by a few clinical studies. However, no studies have clarified how bone healing at the osteotomy site progresses after this surgery or when bone union is completed.
PURPOSE: To clarify how bone healing at the osteotomy site progresses following iVHTO with LCP fixation and to determine when bone union is completed, using a quantitative radiological method.
METHODS: One hundred and nine knees of 96 patients (55 men and 54 women) who underwent this procedure were followed up for a minimum of 24 months after surgery. The age averaged 61.3 years. Radiographs were taken at 5, 8, 12, 16, 20, 24, 36, 52, and 104 weeks after surgery. In addition, computed tomogram (CT) was taken at 5, 12, and 24 weeks. Three experienced surgeons independently observed the radiographs and CT images. To quantitatively assess the time required to complete bone union (bone union time) at the osteotomy site, the radiographic union score for tibial fractures (RUST) was used. In addition, the bone union between the closing wedge osteotomy surfaces inside the tibia was evaluated with the modified RUST system using CT images (RUST-CT). The time when the total score of either the RUST or RUST-CT reached the maximum score of 12 points was defined as the time of bone fusion at the osteotomy site of each patient. Two-year follow-up outcomes were evaluated with the complication rate, JOA score, Lysholm score, and KOOS. RESULTS: 1) The progression of bone healing at the osteotomy site after iVHTO with LCP fixation could be classified into 3 types. Type 1 is characterized by the early completion of the bone union via direct healing, in which the trabecula-like bone columns penetrating the narrow gap between the osteotomy surfaces were formed without extraosseous bridging callus formation. A characteristic of Type 2 is that the bone union is completed via indirect healing, in which extraosseous bridging callus was formed beyond the osteotomy site. Type 3 is characterized by a large radiolucent zone that appears at the osteotomy site at 5 weeks postoperatively. The incidence of Type 1, 2, and 3 was 75.2%, 18.3%, and 6.4%, respectively. 2) The mean bone union time was 10.6 ± 2.2 weeks in the Type 1 knees, 16.8 ± 4.2 weeks in the Type 2 knees, and 22.3 ± 2.1 weeks in the Type 3 knees, showing significant differences among the 3 types ($p<0.001$). In the 102 knees classified as Types 1 and 2 (93.6% of all 109 knees), the bone union time averaged 11.0 ± 2.3 weeks. (3) In clinical outcomes, the complication rate was 3.6% in Type 1, 15.0% in Type 2, and 100.0% in Type 3, showing significant differences ($p<0.001$) among the 3 types. One Type-3 knee requiring additional surgery was excluded from the 2-year follow-up evaluation. In the remaining 108 knees, all scores were significantly improved in each type ($P<0.001$), while there were no significant differences in these three scores among the three types.
CONCLUSION: The fact that the Type 1 bone healing occurred in 75.2% is a unique feature of iVHTO with LCP fixation. Early completion of bone union with rare complications is one of the clinical advantages of this iVHTO procedure.

OS12-5



Optimized Additional Screw Technique to Enhance Early Bone Union in Hybrid Closed-Wedge High Tibial Osteotomy: A Retrospective Comparative Study

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Introduction:
Hybrid closed-wedge high tibial osteotomy (HCWHTO) effectively corrects varus deformity in medial-type knee osteoarthritis, but complete transection at the osteotomy site may delay bone union. Additional interfragmentary screws have been proposed to enhance stability and promote healing, though previous methods often suffered from insufficient compression and non-perpendicular trajectories. We developed a modified additional-screw technique designed to optimize screw orientation, timing of insertion, and interfragmentary compression. This study compared early bone union outcomes between HCWHTO performed with and without this modification.
Methods:
We retrospectively reviewed 43 knees (38 patients) that underwent HCWHTO at our institution from June 2020 to June 2024. Since September 2022, an additional screw technique was introduced (Group A: n = 21); earlier cases did not receive it (Group B: n = 22). After osteotomy and correction, a lateral locking plate (Tris lateral plate-2) was applied. Before final plate locking, one to three tip-threaded 4.5-mm cannulated cancellous screws (CCSs) were inserted medially. The guidewire entry point was positioned near the distal hole of the plate and adjusted perpendicular to the osteotomy line on the anteroposterior fluoroscopic view, with screw threads engaging the posterior tibial cortex to ensure compression. Postoperative rehabilitation protocols were identical between groups.
Primary outcomes included unplanned reoperation within three months for impaired union and CT-based union at three months using the Tomographic Union Score (TUS; 1–4 scale). Continuous variables were analyzed using the Mann–Whitney U test and categorical variables using the chi-square test, with significance set at $p < 0.05$.
Results:
Unplanned reoperation for impaired union occurred in one knee (4.8%) in Group A and three knees (13.6%) in Group B ($p = 0.32$). The mean lateral-side TUS at three months was significantly higher in Group A (3.3 ± 0.5) than in Group B (1.9 ± 0.8; $p < 0.001$), while TUS values for other regions did not differ significantly.
Conclusion:
The modified additional-screw technique achieved significantly faster bone union at the lateral aspect of the osteotomy at three months. This improvement may result from perpendicular screw orientation providing direct compression and enhanced rotational stability. Engagement of the posterior cortex allowed slender CCSs to generate sufficient torque, following the “lag-before-plate-locking” principle known from fracture fixation. These findings suggest that the additional screws contribute to reliable interfragmentary compression and early osseous bridging, thereby promoting accelerated bone healing. The optimized technique—characterized by perpendicular trajectories, early interfragmentary compression before plate locking, and posterior cortical engagement—appears to enhance early bone healing and may contribute to improved postoperative recovery after HCWHTO.

OS12-6

Risk Factors for Delayed Bone Union After OWHTO

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Introduction/Purpose
Open-wedge high tibial osteotomy (OWHTO) is a widely performed procedure for medial compartment osteoarthritis and varus knee deformity. However, delayed bone union remains a clinical concern, potentially affecting postoperative outcomes.
The purpose of this study is to investigate the risk factors for delayed bone union after OWHTO.
Material and Methods
A retrospective case–control study was conducted on 100 consecutive knees that underwent OWHTO between 2016 and 2024. The mean patient age was 65.1 years. All procedures were performed using a standardized technique with β-tricalcium phosphate inserted into the osteotomy gap and fixation achieved with a locking plate system. Bone union was evaluated at one year postoperatively using the Van Hemert classification. Delayed bone union was defined as Phase 2 or lower on the Van Hemert classification. Statistical analysis was performed to evaluate the association between delayed bone union and patient characteristics, intraoperative factors, and pre- and postoperative radiographic parameters. Logistic regression analyses were performed to determine independent risk factors for delayed bone union.
Results
Delayed bone union was observed in 21 knees (21%) at one year postoperatively. Multivariate analysis identified significant associations between delayed bone union and age ($p = 0.01$), plate positioning angle ($p < 0.01$), lateral hinge position ($p = 0.03$), and changes in Posterior tibial slope (PTS) before and after surgery ($p = 0.02$). Notably, the presence or absence of a lateral hinge fracture did not significantly impact bone union.
Conclusion
Delayed bone union after OWHTO is influenced by several factors, including age, plate positioning angle, lateral hinge position, and PTS changes. Proper surgical planning, including optimal lateral hinge positioning, appropriate plate placement, and control of postoperative PTS alterations, may contribute to reduce the risk of delayed union and improve clinical outcomes.

OS13-1

Effect of MOWHTO Versus UKA on Mental Health: A comparative study with propensity score matched analysis

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Purpose:
MOWHTO and UKA are both viable treatments of knee osteoarthritis (KOA). This study aims to compare the effect of MOWHTO and UKA on mental health in patients with KOA.
Methods:
In this retrospective cohort study, data was collected from patients who underwent MOWHTO and UKA between 2019 and 2023 in a single tertiary institution. The main outcome score, Short Form-36 Mental Component Score (SF-36 MCS), was recorded at baseline, six months and two years post procedure. Secondary outcomes included the SF-36 Physical Component Score (PCS) and Oxford Knee Score (OKS).
There were a total of 105 MOWHTOs and 89 UKAs. Propensity score matching (PSM) was performed, accounting for preoperative scores, age, gender and body mass index (BMI), before statistical analysis. A multiple linear regression was performed to identify factors associated with postoperative MCS. The level of significance was set at $p < 0.05$.
Results:
PSM resulted in a final analysis of 51 cases of MOWHTO and UKA each. Both groups were similar in age (58.5 vs 59.2, p=0.49), BMI (28.6 vs 28.3, p=0.83), gender distribution (p=0.69) and OA severity based on KL grading (p=0.37). Preoperative outcome scores between both groups were similar (MCS: MOWHTO 51.0 vs UKA 54.1, p = 0.19; PCS: MOWHTO 32.4 vs UKA 33.8, p = 0.35; OKS: MOWHTO 34.1 vs UKA 34.4, p = 0.87). On two year follow up, both groups achieved similar improvement in SF-36 MCS (MOWHTO 55.9 vs UKA 58.9, p=0.10), SF-36 PCS (MOWHTO 46.7 vs UKA 48.2, p=0.43) and OKS (MOWHTO 19.6 vs UKA 17.6, p=0.09). Through an overall statistically significant regression model ($F(8,93)=2.72$, p=0.0097), we found that preoperative MCS was significantly associated with postoperative MCS ($\beta = 0.30$, p = 0.003).
Conclusions:
In patients with KOA, similar improvements in mental health outcomes were achieved with MOWHTO and UKA at 2 years.

OS13-2

An Extended-Release Sebacoyl Dinalbuphine Ester for Perioperative Pain Management in Improving Enhanced Recovery After Surgery in Total Knee Arthroplasty

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Purpose: Perioperative pain management plays an important role in improving enhanced recovery after surgery (ERAS) in total knee replacement. This retrospective study aimed to observe the efficacy and safety of mixed κ agonist-μ antagonist Sebacoyl dinalbuphine ester (DS, Naldebain®) use along with and without parecoxib (Dynastat®), a COX-2 selective inhibitor, when necessary for the management of post-total knee arthroplasty pain.
Patients and Methods: We reviewed electronic medical records of patients with total knee arthroplasty admitted from January 2018 to May 2024, who received a single dose of DS, 150 mg intramuscularly 24 ± 12 h before surgery. Some of the patients also take an additional dose of parecoxib within 24 hours post-surgery. We included 300 patients, which were divided into three groups. DS group (n = 103) received 150 mg DS intramuscularly 24 ± 12 hours preoperatively. DS/Parecoxib group (n = 79) received DS plus parecoxib within 24 hours postoperatively. NerveBlock group (n = 118) received conventional perioperative nerve block without DS or parecoxib. Multimodal pain control with oral and intravenous analgesics was applied. We analyzed the maximum numerical rating scale for static and dynamic pain scores and other pain control medication consumption up to 120 hours after the operation.
Results: The analysis revealed no statistically significant differences between the three treatment groups regarding the average visual analog scale pain scores in the post-operative anesthesia care unit (PACU) and at 24, 48, 72, 96 and 120 hours following the procedure. However, both DS and DS/Parecoxib groups showed significantly lower consumption of Ultraphen (DS- NerveBlock, p = 0.047; DS/Parecoxib- NerveBlock, p = <0.001) and etoricoxib (DS- NerveBlock, p = 0.007; DS/Parecoxib- NerveBlock, p = 0.007) compared to the Nerve Block group. Furthermore, the DS/Parecoxib group had significantly fewer patients requiring postoperative tramadol than both the DS (25.1% vs. 14.0%, p = 0.017) and Nerve Block groups (25.8% vs. 14.0%, p = 0.016), indicating an opioid-sparing effect. Other oral and opioid pain control medications did not show any statistically significant differences.
Conclusion: Preoperative administration of dinalbuphine sebacate (DS) appears to offer a beneficial analgesic effect and may help reduce the need for additional oral analgesics when compared to conventional nerve block strategies alone. While pain scores were comparable between patients receiving DS alone and those receiving DS combined with parecoxib, the addition of parecoxib was associated with a lower requirement for postoperative tramadol. Considering the substantial pain burden following total knee arthroplasty, a multimodal analgesic approach incorporating DS—with or without adjunctive parecoxib—may be a reasonable strategy to enhance postoperative pain management while minimizing opioid use.

OS13-3

Analysis of factors affecting conversion to total knee arthroplasty after open wedge high tibial osteotomy

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-Introduction/Purpose
Open wedge high tibial osteotomy (OWHTO) has become a widely accepted treatment for medial compartment knee osteoarthritis (OA) and spontaneous osteonecrosis of the knee (SONK). However, some patients eventually require TKA due to disease progression or loss of correction. Because TKA after OWHTO is technically demanding and associated with higher complication rates, it is important to understand the factors leading to conversion.
This study aimed to evaluate the long-term survival rate after OWHTO and to identify clinical and radiographic factors associated with conversion to TKA.
-Material and Methods
We retrospectively reviewed 48 knees in 39 patients who underwent OWHTO for medial-type OA or SONK between 2005 and 2018 at our institution or affiliated hospitals. The target postoperative mechanical axis (%MA) was set at 62.5%. The study included 9 men and 30 women with a mean age of 55 years and a mean follow-up of 102 months (range, 63–181 months). Radiographic parameters such as hip–knee–ankle angle (HKAA), medial proximal tibial angle (MPTA), joint line convergence angle (JLCA), %MA, and the change in %MA (Δ%MA) were measured preoperatively, at plate removal, and at final follow-up. Conversion to or indication for TKA was defined as the endpoint. Kaplan–Meier survival analysis and both univariate and multivariate analyses were performed to identify factors associated with TKA conversion.
-Results
Of the 48 knees, 44 (10 men and 34 women) remained intact, while 4 knees (all in women) underwent or were indicated for TKA. The 5-year and 10-year survival rates were 100% and 85%, respectively. Univariate analysis showed significant differences between the survival and TKA groups in BMI, preoperative JLCA, final HKAA, final %MA, and Δ%MA. In multivariate analysis, higher BMI, larger preoperative JLCA, and greater Δ%MA were identified as independent predictors of TKA conversion.
-Conclusion
The 10-year survival rate of OWHTO, using conversion to TKA as the endpoint, has been reported to exceed 80% in previous studies. In our series, the 10-year survival rate was also 85%, indicating favorable mid- to long-term outcomes. Analysis of the factors influencing conversion to TKA revealed that high BMI was a preoperative risk factor, and postoperative correction loss (Δ%MA) was a postoperative factor contributing to conversion.
These findings suggest that, to avoid conversion to TKA after OWHTO, careful patient selection in obese individuals and maintenance of postoperative limb alignment are particularly important.

OS13-4

Temporal Changes in Joint Awareness After Medial UKA and Opening-Wedge High Tibial Osteotomy: A Propensity-Matched Comparative Study

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Purpose: Joint awareness (JA) refers to conscious perception of the joint, with its absence representing the ultimate treatment goal. This study aimed to compare longitudinal JA changes after unicompartmental knee arthroplasty (UKA) versus opening-wedge high tibial osteotomy (OW-HTO).
Material and Methods: We conducted a single-center retrospective review of 115 UKA and 69 OW-HTO patients with >2 years follow-up. JA was assessed via Forgotten Joint Score-12 (FJS) preoperatively, at mean 16.0 months (1st.FJS), and 33.8 months (2nd. FJS) postoperatively. Propensity score matching created 63 pairs with equivalent baseline JA. Multiple regression analysis with bias adjustment was performed ($p<0.05$).
Results: Age: 75.1 vs 56.7 years ($p<0.001$) for UKA vs OW-HTO. Preoperative FJS: 21.5 vs 21.4 (n.s.), 1st.FJS: 53.3 vs 53.6 (n.s.), 2nd.FJS: 52.3 vs 65.8 ($p=0.002$). JA remained stable after UKA but significantly improved after OW-HTO ($p<0.001$). Multiple regression revealed UKA selection as a negative predictor of 2nd.FJS.
Conclusion: OW-HTO demonstrated superior JA improvement at 33.8 months versus UKA despite similar early outcomes. Greater alignment changes and plate removal may contribute to progressive JA improvement in OW-HTO. Limitations include the retrospective single-center design.

OS13-5

Evaluating OW-HTO and UKA in patients in their 60s: A comparative analysis

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-Introduction/Purpose
High tibial osteotomy (HTO) is a widely performed procedure and has achieved good medium- to long-term clinical outcomes in patients with knee osteoarthritis. Unicompartmental knee arthroplasty (UKA) is increasingly being positioned as a joint-preserving procedure, with discussions around its clinical indications. Particularly for younger, active patients with medial compartment osteoarthritis, the choice between osteotomy or UKA remains a topic of ongoing debate. This study examined the clinical outcomes of open-wedge HTO (OW-HTO) and UKA (Oxford® Partial Knee) in patients in their 60s with relatively high activity levels (Kellgren-Lawrence grade 3/4, UCLA activity score ≤8).
-Material and Methods
We analyzed patients treated between 2018 and 2023 at two hospitals: Fukuoka University Hospital, where only OW-HTO was performed, and Hamana Hospital, where only UKA was performed. The postoperative outcomes at one year, including range of motion, Kellgren-Lawrence grade, UCLA activity score, visual analog scale (VAS), Japanese knee osteoarthritis measure (JKOM; pain and stiffness, activities of daily living (ADL), social activity, health conditions, and total score), as well as complications were assessed in 42 patients who underwent OW-HTO and 41 who underwent UKA. After propensity score matching to standardize patient backgrounds, 28 patients from each group were evaluated.
-Results
The only difference in patient background between the OW-HTO and UKA groups was the Kellgren-Lawrence grade. In the comparison of postoperative outcomes, UKA demonstrated better clinical outcomes for pain, stiffness, and ADL at 3 and 6 months, whereas HTO showed better outcomes for general health over the same period. At the final follow-up, no differences were observed between the two surgical techniques. Analysis of patients with Kellgren-Lawrence grade 3 revealed that HTO demonstrated better outcomes for pain, stiffness, and social function at 12 months postoperatively. In contrast, analysis of patients with Kellgren-Lawrence grade 4 revealed that UKA showed better outcomes for pain, stiffness, and ADL at 3 and 6 months postoperatively, whereas HTO showed better outcomes for general health over the same period. Complications included three patients with type 1 hinge fractures in the HTO group and one bearing dislocation in the UKA group, with no reported infection.
-Conclusion
In patients with UCLA activity score ≤8, no differences in clinical outcomes were observed between the two surgical techniques at 12 months, although the intermediate outcomes were better following UKA. For patients with Kellgren-Lawrence grade 3, certain clinical outcomes at one year were better with HTO, whereas for those with Kellgren-Lawrence grade 4, the intermediate outcomes were generally better with UKA, suggesting that UKA may be the preferred option for this group of patients.

OS13-6

Impact of Preoperative Limb Alignment and Deformity on Postoperative Limb Alignment in Unicompartmental Knee Arthroplasty

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-Introduction/Purpose
In Unicompartmental Knee Arthroplasty (UKA), achieving good postoperative lower limb alignment is crucial for long-term success. Although Kennedy et al. reported that ideal postoperative weight-bearing line in medial UKA is recommended to pass through between the center of the medial tibial articular surface and the lateral intercondylar eminence (Zone K). However, the preoperative factors affecting the postoperative wight-bearing line are not fully understood. This study aims to identify preoperative factors that contribute to the appropriate weight-bearing line after UKA.
-Material and Methods
This study included 92 knees diagnosed with either isolated medial compartmental osteoarthritis or spontaneous osteonecrosis. All cases received primary medial fixed-bearing UKA (Partial Knee System; Zimmer Biomet). Patients were categorized into two groups: Group K, where the postoperative weight-bearing axis passed through zone K, and Group M, where it passed more medially. Preoperative patient characteristics (sex, age, BMI, range of motion) and radiographic parameters (%MA, MPTA, mLDFA, JLCA) were compared between the two groups.
-Results
Group K included 50 knees, and Group M included 42 knees. No patient had detected postoperative weight-bearing line at lateral compartment. There were no significant differences in patient characteristics between the groups. Preoperative %MA (Group M: 7.3±11.5%, Group K: 23.5±12.3%), and MPTA (Group M: 82.1±3.4°, Group K: 84.3±2.5°) ($p<0.01$) were detected significant difference between the groups. Logistic regression analysis revealed that preoperative %MA and MPTA were significant factors, with cutoff values of 15.9 for %MA and 84.4° for MPTA identified by ROC curve analysis. Comparing the area under the curve, preoperative %MA was found to have the most significant impact (%MA: 0.83, MPTA: 0.69, $p=0.034$).
-Conclusion
The importance of %MA in achieving optimal alignment in UKA is similar to its role in around the knee osteotomy. %MA is a critical parameter because it is not influenced by skeletal structure such as bone length, bowing and individual height. The current study revealed that a preoperative %MA of less than 15% and an MPTA of less than 84° were associated with a higher risk of misalignment after UKA, which underscores the need for careful consideration of %MA during preoperative planning. In case of small MPTA, intraoperative adjustments become paramount. Specifically, fine tuning the amount of tibial resection and carefully selecting the thickness of the insert are essential in achieving the desired intra-articular correction. These adjustments help ensure that the postoperative limb alignment closely with zone K, which is crucial for the long-term success of UKA.

OS14-1

Alignment changes after open-wedge high tibial osteotomy result in oloading in the patellofemoral joint: a SPECT/CT analysis

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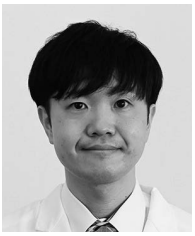
-Introduction/Purpose
The patellofemoral (PF) joint may be adversely afected by medial open-wedge high tibial osteotomy (OWHTO). This study aimed to evaluate the PF compartmental changes using combined single-photon emission computed tomography (SPECT) and conventional computed tomography (CT) after OWHTO to provide clinical guidance regarding the PF joint pressure and force.
-Material and Methods
Patients with medial osteoarthritis and varus malalignment > 5° were treated using OWHTO. Patients with a minimum 2-year follow-up were included in the study. The patellar positions were evaluated based on the radiographic parameters. The changes in chondral lesions during second-look arthroscopic examination were evaluated, and the PF joint arthritis grade was recorded on patellar Merchant radiographs using Kellgren–Lawrence classiication. The PF compartmental changes according to SPECT/CT analysis after OWHTO were evaluated in all patients. The scintigraphic uptake was graded on four scales. Patients were divided into improved and unimproved groups according to the PF compartmental grade using the SPECT/CT uptake grading system
-Results
At a mean follow-up period of 47.0 months (range 25–74 months), the mean mechanical femorotibial angle changed signiicantly from varus 6.3° (range 5–12°) to valgus 2.6° (range 0–8°); $p < 0.001$) postoperatively. The radiological parameters presenting patellar positions, including the tibial slope, patellar convergence angle, and lateral tilt angle, did not change signiicantly between the preoperative values and the 2-year follow-up values. The mean patellar height signiicantly decreased (0.07 ± 0.14, $p = 0.001$ according to the Blackburn–Peel index and 0.32 ± 0.23, $p < 0.001$ using the modiied Insall–Salvati ratio). The average tibial tubercle to trochlear groove (TT–TG) distance signiicantly decreased from 14.1 to 12.2 mm ($p < 0.001$). The Q angle also signiicantly decreased from 9.8o to 7.7o ($p = 0.008$). Chondral lesions of the patella and trochlear groove revealed signiicant deterioration; at 2 years after OWHTO, the arthritic grades of the PF joints worsened signiicantly, as determined by radiography ($p = 0.007$). Scintigraphic uptake in the PF joint was signiicantly lower (from 2 to 1) at 2 years postoperatively compared to that immediately after the index operation ($p < 0.001$). Only 4 of 56 (7.1%) patients showed increased uptake. Comparison between the improved and unimproved groups according to scintigraphic uptake changes revealed that the changes in the cartilage status on the patellar undersurface and TT–TG distance were the most signiicant predictive factors of increased scintigraphic uptake in the PF joint after OWHTO.
-Conclusion
Alignment correction by OWHTO result in PF compartment oloading and should be considered when identifying the surgical indications for OWHTO

OS14-2



Medial Closed Wedge Distal Femoral Osteotomy for Osteonecrosis of the Lateral Femoral Condyle with Valgus Deformity: A Case Series

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-Introduction/Purpose
Spontaneous osteonecrosis of the knee (SONK) rarely occurs in the lateral femoral condyle (LFC), and reports on the application of medial closed wedge distal femoral osteotomy (MCWDFO) for this condition are scarce. This study aims to evaluate the clinical outcomes of MCWDFO in patients with SONK localized to the LFC.
-Material and Methods
We retrospectively reviewed four knees in four male patients (mean age at surgery:59.3 ± 7.2 years) who underwent MCWDFO for SONK of the LFC. The following parameters were assessed preoperatively and postoperatively: range of motion (ROM) of the knee, lower limb alignment (% mechanical axis [%MA], hip-knee-ankle angle [HKA], mechanical lateral distal femoral angle [mLDFA]), and clinical outcomes including visual analog scale (VAS) for pain and the Knee injury and Osteoarthritis Outcome Score (KOOS).
-Results
Postoperative assessments demonstrated improvements across all evaluated parameters. Knee flexion increased from 120.0 ± 12.3° preoperatively to 124.0 ± 11.1°, while extension improved from -6.3 ± 2.5° to -2.5 ± 2.9°. %MA shifted from 62.7 ± 7.1% to 34.9 ± 6.6%, and HKA changed from 3.6 ± 2.2° to -2.1 ± 2.9°. mLDFA increased from83.5 ± 1.0° to 87.8 ± 1.4°, reflecting improved distal femoral geometry. VAS decreased from 63.0 ± 32.6 mm to 14.1 ± 4.6 mm. KOOS improved from 50.3 ± 21.2 to 80.0 ± 6.8.
-Conclusion
Surgical intervention was performed based on the indications for MCWDFO in lateral compartment osteoarthritis, yielding favorable postoperative outcomes. MCWDFO appears to be an effective surgical option for SONK of the LFC accompanied by valgus deformity, particularly when the deformity originates from the distal femur.

OS14-3

A Case of Femoral Fracture after Implant Removal Following Distal Femoral Osteotomy

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Introduction:
Distal femoral osteotomy (DFO) is an effective joint-preserving surgery for valgus-type osteoarthritis of the knee, especially in relatively young patients. Reported postoperative complications include hinge fracture, delayed union, and loss of correction. We experienced a case of femoral fracture that occurred after implant removal, originating from a screw hole.
Case:
A 50-year-old woman underwent DFO for valgus osteoarthritis of the right knee. Bone union was confirmed one year after surgery, and implant removal was subsequently performed. About one month after removal, she developed swelling and pain in the right knee. At three months, she complained of pain during long-distance walking. Four months after the procedure, she felt a cracking sound in her right knee and became unable to stand. Radiographs revealed a distal femoral fracture starting from the screw hole proximal to the osteotomy site. Consequently, internal fixation was performed, and bone union was achieved one year later. The patient remained pain-free in the right knee thereafter.
Discussion and Conclusion:
Implant removal is generally indicated for metal irritation, cosmetic reasons, or at the request of younger patients. However, complications such as infection and refracture are known to occur. In particular, when the screw hole diameter is large, local stress concentration and reduced bone strength can lead to refracture. In this case, we considered that the bone around the screw hole had weakened, resulting in the fracture. The indication for implant removal after knee osteotomy should therefore be carefully evaluated, taking the patient's background into consideration, and appropriate postoperative management is essential.

OS14-4

Anterior-Posterior Hinge Width and Hinge Fracture Predict Delayed Union after Medial Closed-Wedge Distal Femoral Osteotomy

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Introduction:
Delayed bone union after medial closed-wedge distal femoral osteotomy (MCWDFO) has been widely reported, and it is clinically important as it may increase the likelihood of additional procedures or other complications. Hinge fracture has been regarded as the main risk factor, while patient factors such as body mass index (BMI) and wedge width have also been examined. In this study, we assessed hinge fracture and introduced the concept of anterior–posterior (AP) hinge width to determine whether these factors were related to bone healing.
Material and Methods:
We retrospectively reviewed 26 consecutive knees treated with MCWDFO for valgus deformity between 2015 and 2018. All procedures were performed as a standard biplane osteotomy and fixed with a locking plate. AP radiographs were obtained every month postoperatively. Hinge union, defined as bone healing at the osteotomy hinge area, was the main criterion for bone union, and delayed hinge union was defined as healing > 90 days. AP hinge width, measured on postoperative axial CT at the hinge level, was expressed in millimeters and as a percentage of distal femoral diameter. Potential confounding factors, including age, gender, BMI, and the wedge width, were also evaluated. As only one patient was a smoker, smoking was excluded from analysis. Continuous variables were compared using the Mann–Whitney U test, and categorical variables with Fisher's exact test. Logistic regression was used to identify predictors of delayed hinge union, and receiver operating characteristic (ROC) curve analysis was applied to determine the cutoff value for AP hinge width. A p-value < 0.05 was considered statistically significant. This study was approved by the institutional review board, and written informed consent was obtained from all patients.
Results:
The study included 26 knees with a mean age of 53.8 ± 12.4 years and a mean BMI of 26.4 ± 4.6 kg/m². The mean wedge width was 7.4 ± 2.4 mm, and the mean AP hinge width was 19.3 ± 8.6 mm (45.9 ± 19.1%). Delayed hinge union occurred in 13 of 26 knees (50%). The delayed group had a significantly smaller AP hinge width compared with the non-delayed group (17.3 mm vs. 23.5 mm, $p = 0.016$). Logistic regression showed AP hinge width (per mm) was a significant predictor of delayed union (OR 0.83; 95% CI, 0.70–0.98; $p = 0.032$). Hinge fracture was also associated with delayed union (OR 8.80; 95% CI, 1.3–57.4; $p = 0.041$). Other potential factors, including age, BMI, and wedge width, were not significant. ROC analysis yielded an AUC of 0.781 (95% CI, 0.58–0.94). An optimal AP hinge width cutoff of 20 mm provided sensitivity of 84.6% and specificity of 69.2%.
Conclusion:
AP hinge width was closely related to hinge healing after MCWDFO, and a width of at least 20 mm appeared to reduce the risk of delayed hinge union. Hinge fracture was also associated with delayed healing, although the wide CI requires cautious interpretation. Securing adequate AP hinge width should be considered an important factor for bone union.

OS14-5

The influence of hinge width ratio on risk of intraoperative hinge fracture in MCWDFO: A finite element analysis

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Introduction: Intraoperative hinge fracture is a common complication of medial closing wedge distal femoral osteotomy (MCWDFO). We have previously reported that the condylar hinge position would reduce the risk of intraoperative hinge fracture in MCWDFO regardless of bi-plane (BP) or single-plane (SP) technique. In the BP technique, a thicker anterior flange can result in a narrower hinge width. However, the influence of hinge width on hinge fracture is unknown.
This study aimed to investigate the influence of hinge width on the risk of intraoperative hinge fracture in MCWDFO using finite element analysis (FEA). We hypothesized that the risk of intraoperative hinge fracture would be increased as hinge width becomes narrower in BP-MCWDFO, even if the hinge position is appropriate.
Material and Methods: Three-dimensional femur models were created from preoperative computed tomography (CT) images of 11 knees that underwent MCWDFO, and virtual SP- and BP-MCWDFO were performed using software. For BPMCWDFO, the lateral hinge width ratio [(hinge width / total antero-postero femur width at the hinge level) x 100 (%)] was changed to 80%, 67%, 50%, and 33%. The hinge position was set as the supracondylar hinge (S) and the condylar hinge (C). In the supracondylar hinge models, a BP model with an 80% hinge width ratio was created. Namely, six models were created: (a) SP-C, (b) BP80-C, (c) BP67-C, (d) BP50-C, (e) BP33-C, (f) BP80-S. The correction angle was set at 5 degrees. As the boundary condition, the most proximal parts of the models were fixed. The displacements at the femoral medial condyle were set to close the wedge completely. Young's modules were calculated using their CT values by Keyak et al.'s equation. A 1.5 mm tetrahedral mesh was selected, and a 0.4 mm shell was pasted to the surface. Nonlinear finite element analysis was conducted. If the failure shell elements were found throughout the hinge area from anterior to posterior during closure of the osteotomy gap, the condition was defined as a complete hinge fracture. We investigated two conditions: (1) the number of intraoperative fractures, (2) the maximum value and distribution of Drucker-Prager equivalent stress in the hinge area were compared among each model after closing the gap.
Results: The number and percentage of intraoperative hinge fractures in each model were (a) 3 (27.3%), (b) 4 (36.4%), (c) 4 (36.4%), (d) 8 (72.7%), (e) 10 (90.9%), (f) 11 (100%). (Significant difference between (a) and (f): $p < 0.05$). There was a tendency that the fracture rate was higher in the smaller hinge width ratio of ≤ 50% models (d) and (e), than that in models (a), (b), and (c), without a statistically significant difference. The maximum value of Drucker-Prager equivalent stress was (a) 118.8 ± 25.7 MPa, (b) 126.1 ± 59.0 MPa, (c) 126.1 ± 30.1 MPa, (d) 130.4 ± 28.7 MPa, (e) 104.9 ± 22.0 MPa, (f) 169.6 ± 42.3 MPa. Model (f) was significantly higher than all others ($p < 0.05$). No other between-group differences were significant.
Conclusions: Hinge width did not affect the maximum Drucker-Prager equivalent stress. However, in the narrower-hinge model, failure shell elements propagate more readily from the anterior to the posterior. In BP-MCWDFO, the risk of hinge fracture can increase as the hinge width ratio decreases, even if the hinge is placed in the lateral condylar area. The flange thickness should be adjusted to ensure sufficient hinge width when using the BP technique.

OS14-6

Intra-articular Injection of Mesenchymal Stem Cells After High Tibial Osteotomy in Osteoarthritic Knee: Two-Year Follow-up of Randomized Control Trial

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-Introduction/Purpose Intra-articular injection of adipose-derived mesenchymal stem cell (ADMSC) after medial open-wedge high tibial osteotomy (MOWHTO) would be a promising disease-modifying treatment by correcting biomechanical and biochemical environment for arthritic knee with varus malalignment. However, there is a paucity of clinical evidence of the treatment. The purpose of our randomized controlled trial (RCT) was to evaluate the articular cartilage regeneration, clinical improvements, and safety of a single intra-articular injection of autologous ADMSCs after MOWHTO compared to MOWHTO alone until 2-year follow-up. We hypothesized that patients receiving an intra-articular injection of autologous ADMSCs after MOWHTO would show better articular cartilage regeneration and greater clinical improvements in safety than MOWHTO alone.
-Material and Methods This prospective, randomized, open-label, blind end-point (PROBE), 2-arm parallel, controlled trial was conducted at a single institution. Eligible patients were aged 20-80 years and had symptomatic medial compartment knee OA (Kellgren-Lawrence[K-L] grades 2-4) assessed according to the American College of Rheumatology criteria with varus malalignment more than 5 degrees. From November 2016 to February 2018, 26 patients (26 knees) were enrolled in this prospective RCT and allocated to either the MOWHTO with ADMSC-injection group (n = 13) or the control (MOWHTO-alone) group (n = 13). The primary outcome was the serial changes of cartilage defect on periodic magnetic resonance imaging (MRI) evaluation using valid measurements until postoperative 24 months. Secondary outcomes were the 2-stage arthroscopic evaluation for macroscopic cartilage status and the postoperative functional improvements of patient-reported outcome measures until the latest follow-up. Furthermore, safety profiles after the treatment were evaluated.
-Results Both groups showed a gradual decrease in mean cartilage defect area up to 24 months on serial MRIs. ADMSC group demonstrated a greater decrease (from 205.0 ± 181.4 mm² to 81.5 ± 186.1 mm²) compared to the control group (from 296.1 ± 203.0 mm² to 178.9 ± 155.6 mm²), but the difference between groups was not statistically significant ($P > 0.05$). Cartilage regeneration showed significantly higher in the ADMSC group than in the control group (3 months: 43.3% ± 30.1 vs 17.4% ± 20.9, P = .018; 6 months: 65.3% ± 40.1 vs 27.4% ± 36.7, P = .019; 18 months: 74.9% ± 37.9 vs 38.5% ± 43.2, P = .031; 24 months: 81.1% ± 34.4 vs 44.4% ± 43.8, P = .026). The degree of articular cartilage regeneration
showed significantly better in the ADMSC group (total regeneration, 69.2%) than in the control group (total regeneration, 23.1%; P =.042) by macroscopic staging assessment through 2-stage arthroscopy. Although it was not significant, functional improvements after the treatment showed a tendency to be greater in the ADMSC group than in the control group from 18 months after the treatment. No treatment-related adverse events, serious adverse events, and postoperative complications occurred in all cases. -Conclusion Concomitant intra-articular injection of ADMSCs with MOWHTO had advantages over MOWHTO alone in terms of cartilage regeneration with safety at 2-year follow-up, suggesting potential disease-modifying treatment for knee OA with varus malalignment.

Oral Presentation 15 DFO and OW PF joint 2

OS15-1

Detection of Lateral Hinge Fractures After Medial Closing Wedge Distal Femoral Osteotomy: Computed Tomography Versus Plain Radiography

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-Introduction/Purpose
Limited evidence exists in the literature regarding the detection rates of lateral hinge fracture (LHF) on computed tomography (CT) after medial closing wedge distal femoral osteotomy (MCDFO). Moreover, the effect of LHF on bone healing after MCDFO remains unclear. The purposes of this study were (1) to investigate the detection rates of LHF as shown on plain radiography and CT after MCDFO and (2) to compare the incidence of problematic bone healing between knees with LHF and those without LHF.
-Material and Methods
Patients who underwent MCDFO between May 2009 and July 2019 were retrospectively evaluated. The presence of LHF was evaluated using immediate postoperative plain radiography and CT. The detection rates of LHF on plain radiography and CT were compared. The incidence of problematic bone healing (nonunion, delayed union, and loss of correction) was also compared between the knees with LHF and those without LHF.
-Results
A total of 55 knees of 43 patients (mean age, 37.7 6 16.7 years) were included in the study. Although 33 LHFs were detected on CT, only 19 LHFs were detected on plain radiography. The detection rate of LHF was significantly higher on CT than on plain radiography (60% vs 34.5%; P = .008). At 1-year follow-up, 10 cases of problematic bone healing (1 nonunion, 4 delayed unions, and 5 losses of correction) were identified. The incidence of problematic bone healing was significantly higher in the knees with LHF than in those without LHF as shown on plain radiography (36.8% vs 8.3%; P = .001) and CT (30.3% vs 0%; P = .004).
-Conclusion
LHF can be detected better on CT than on plain radiography and has a negative effect on bone healing after MCDFO. For patients with LHF detected on either plain radiography or CT, careful rehabilitation with close follow-up is recommended.

OS15-2

Optimizing Plate Position for Biomechanical Stability in Medial Closing-Wedge Distal Femoral Osteotomy

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-Introduction/ Purpose: Despite efforts to improve mechanical stability and reduce complications after medial closed-wedge distal femoral osteotomy (MCDFO), the role of plate positioning in determining mechanical stability has not yet been elucidated. The purpose of this study was to determine the biomechanically optimal plate position during medial closing-wedge distal femoral osteotomy (MCDFO) using finite element analysis.
-Material and Methods: Five distinct three-dimensional finite element models of the distal femur and implant (TomoFix Medial Distal Femur Plate and screws) were developed from computed tomography data, and a virtual MCDFO was performed. To identify the biomechanically optimal implant positioning, nine unique configurations were created by systematically varying the height (proximal–distal) and depth (anterior–posterior) of the plate in 5 mm increments. Physiological loading conditions were simulated by applying joint loads at 0°, 30°, and 90° of knee flexion. Biomechanical stability of the bone–implant construct, including the osteotomy site, was evaluated based on the following parameters: (1) micromotion at the osteotomy site, (2) mean stress applied to the bone and implant, (3) mean stress in the lateral hinge of the distal femur, and (4) peak von Mises stress (PVMS) on the plate and each screw.
-Results: A total of 30 analyses were conducted by performing six simulations for each model to meet the sample size requirement determined by a priori power analysis. Micromotion at the osteotomy site was significantly reduced with posterior and proximal plate positioning, a trend consistent across all knee flexion angles. Mean stress in the bone and implant showed no clear directional trend depending on plate position, whereas stress in the lateral hinge of the distal femur was lowest with posterior-middle placement and remained consistent across all flexion angles. PVMS revealed that anterior–distal placement tended to produce the highest stresses across the plate and screws—occasionally exceeding the titanium alloy's yield strength—while posterior–proximal repositioning progressively reduced them.
-Conclusions: Positioning the plate as posteriorly as possible while avoiding distal placement may be recommended during MCDFO to optimize the biomechanical stability of the bone–implant construct.

OS15-3

Differences in Lower Limb Mechanical Axis Between Supine and Standing Positions Before and After Medial Closed-Wedge Distal Femoral Osteotomy

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INTRODUCTION: In OWHTO, it has been reported that varus alignment tends to increase in the standing position compared with the supine position before surgery, whereas the difference in %MA between the two positions disappears after surgery. On the other hand, %MA tends to shift laterally in the standing position compared with the supine position before and after MCWDFO. It remains unclear in which cases the postoperative %MA tends to shift laterally in the standing position. Thus, the purpose of this study was to investigate Δ%MA (Δ = standing position – supine position) before and after MCWDFO.
METHODS: Patients who underwent MCWDFO for valgus knee at our hospital between June 2018 and May 2025 were examined. The exclusion criteria were as follows: patients with concomitant MCWHTO or joint reconstruction; preoperative %MA < 50; multi-ligamentous knee injury; valgus deformity after ankle fracture; poor limb positioning on preoperative radiograph; revision surgery due to postoperative fracture and preoperative ΔJLCA greater than 3°. Initially, 43 patients (47 knees) were identified and after applying criteria, 31 patients (34 knees) (18 males/16 females; mean age: 48.4 years) were included. It has been reported that %MA changes by approximately 4% for each 1° of correction angle in MCWDFO. In surgical procedure, a deviation within ±1°(±4%) could be considered acceptable. Therefore, the acceptable range was defined as ±4%, and cases with postoperative Δ%MA within this range were classified as Group I (22 knees, 65%), and cases outside this range were classified as Group O (12 knees, 35%). Parameters such as %MA, HKA angle, JLCA, mechanical LDFA and mechanical MPTA were measured on preoperative and postoperative radiographs in both supine and standing positions.
For comparison between the two groups, an unpaired t-test was performed. A regression analysis was conducted to identify factors associated with the postoperative Δ%MA. A receiver operating characteristic (ROC) analysis was performed to determine the cutoff value of preoperative Δ%MA. Statistical significance was set at $p < 0.05$.
RESULTS: No significant differences in demographic data were observed between the two groups. There were also no significant differences in preoperative supine %MA (Group I: 60.3%, Group O: 58.4%) and preoperative standing %MA (Group I: 62.8%, Group O: 68.2%). Significant differences were observed in preoperative Δ%MA (Group I: 2.5%, Group O: 9.8%), preoperative ΔJLCA (Group I: –0.3°, Group O: –1.1°), postoperative Δ%MA (Group I: –0.5%, Group O: 8.9%) and postoperative ΔJLCA (Group I: 0.1°, Group O: –1.0°). Simple linear regression analysis demonstrated that postoperative Δ%MA was significantly correlated with preoperative Δ%MA ($\beta = 0.72$, $R^2 = 0.53$, $p < 0.0001$) and preoperative ΔJLCA ($\beta = -4.17$, $R^2 = 0.32$, $p < 0.001$). ROC analysis indicated that preoperative Δ%MA ≥ 7% predicted postoperative Δ%MA outside the acceptable range (±4%) with an area under the curve (AUC) of 0.87, sensitivity of 0.77, and specificity of 0.83.
DISCUSSION: Group O had significantly larger Δ%MA both preoperatively and postoperatively, and preoperative Δ%MA was strongly correlated with postoperative Δ%MA. Compared with OWHTO, MCWDFO showed smaller changes in soft tissue balance before and after surgery, suggesting that preoperative soft tissue imbalances may persist postoperatively. ROC analysis suggested that in cases where preoperative Δ%MA exceeded 7%, postoperative Δ%MA was likely to deviate from ±4% range. This finding emphasizes the importance of assessing Δ%MA in preoperative planning for MCWDFO.
CONCLUSION: The difference in preoperative %MA between standing and supine positions was the most relevant predictor of the difference in postoperative %MA between two positions in MCWDFO. Surgeons should be aware that greater difference in preoperative %MA between two positions may indicate residual soft tissue effects that could reduce postoperative alignment accuracy.

OS15-4

Preoperative Predictors of Patellofemoral Osteoarthritis Progression After Open-Wedge High Tibial Osteotomy: A Retrospective Cohort Study

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Background: Progression of patellofemoral osteoarthritis (PFOA) after open-wedge high tibial osteotomy (OWHTO) is a clinically relevant concern, yet its preoperative risk profile remains insufficiently defined. Prior studies commonly judged PFOA progression using Kellgren–Lawrence (KL) grade changes on a single Merchant view, which may miss osteophytes at the superior or inferior poles and underestimate joint-space changes. We developed a two-view radiographic evaluation (Merchant + lateral) focusing on morphological changes (new/enlarged osteophytes and/or joint-space narrowing) and sought to identify preoperative and intraoperative predictors of PFOA progression following OWHTO.
Methods: We performed a retrospective cohort study of consecutive OWHTO cases between January 2014 and December 2019. Of 116 knees in 104 patients enrolled, 114 knees with analyzable patellofemoral radiographs at 4–5 years postoperatively were included. PFOA progression was defined as the presence of either (1) new or enlarged osteophytes or (2) joint-space narrowing detected on at least one of the two views (Merchant and lateral view). Candidate predictors included age, body mass index (BMI), knee extension loss (°), knee flexion (°), preoperative PF and femorotibial (FT) KL grades (per one-grade increase), opening gap (mm), percentage mechanical axis (%MA), medial proximal tibial angle (MPTA), joint-line convergence angle (JLCA), Caton–Deschamps index (CDI), Insall–Salvati ratio (ISR), and patellar tilt (°). After univariable screening with logistic regression, we constructed a prespecified multivariable logistic model limiting the number of covariates by events per variable and using cluster-robust standard errors at the patient level. Discrimination was assessed with the area under the receiver-operating characteristic curve (AUC), and exploratory cut-offs were derived.
Results: PFOA progression occurred in 63/114 knees (55.3%). On univariable analysis, greater preoperative extension loss (odds ratio [OR] 1.17 per 1°, 95% CI 1.05–1.30, p=0.004), higher PF KL grade (OR 1.66 per grade, 95% CI 1.07–2.57, p=0.023), higher FT KL grade (OR 1.64 per grade, 95% CI 1.04–2.60, p=0.034), larger opening gap (OR 1.13 per mm, 95% CI 1.00–1.27, p=0.042), and smaller patellar tilt (OR 0.90 per 1°, 95% CI 0.80–1.00, p=0.043) were significantly associated with progression; age, BMI, %MA, MPTA, JLCA, CDI, ISR, and flexion arc were not (all p>0.05). In the multivariable model, two independent preoperative predictors remained: extension loss (adjusted OR [aOR] 1.20 per 1°, 95% CI 1.07–1.35, p=0.001) and PF KL grade (aOR 1.85 per grade, 95% CI 1.11–3.09, p=0.018). FT KL (aOR 0.93, 95% CI 0.51–1.72, p=0.819) and opening gap (aOR 1.15 per mm, 95% CI 0.99–1.34, p=0.060) were not independently associated after adjustment. Model discrimination was acceptable (AUC 0.74). Exploratory ROC analyses suggested practical thresholds: extension loss ≥5° (AUC 0.67, sensitivity 77%, specificity 56%) and PF KL ≥2 (AUC 0.62, sensitivity 49%, specificity 71%).
Discussion: Using a pragmatic two-view, morphology-based radiographic definition, we found that over half of knees exhibited PFOA progression at mid-term follow-up after OWHTO. Preoperative extension loss—likely reflecting unfavorable patellofemoral contact mechanics with increased PF pressure in flexion—and higher PF KL grade—indicating pre-existing cartilage compromise—were independent predictors. Although opening gap and FT KL grade were associated in unadjusted analyses, their effects attenuated in the multivariable model, suggesting that extension loss and PF degeneration carry the dominant prognostic signal.
Conclusions: PFOA progression after OWHTO was observed in 55.3% at 4–5 years. Preoperative knee extension loss and PF KL grade independently predicted progression. Thresholds of extension loss ≥5° and PF KL ≥2 appear clinically actionable for counseling, surgical planning, and follow-up.

OS15-5

Comprehensive Realignment through Medio-Antero-Distal Tibial Tuberosity Osteotomy (MADD) for Multifactorial Patellar Instability

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Introduction/Purpose: Patellar instability is a challenging condition resulting from multifactorial anatomical abnormalities, including trochlear dysplasia, patella alta, and increased tibial tubercle–trochlear groove (TT–TG) distance. Although medial patellofemoral ligament (MPFL) reconstruction is widely used, isolated soft-tissue procedures may not adequately address structural contributors to maltracking. Distal realignment procedures have therefore been advocated to improve patellofemoral tracking and stability. Medio-antero-distal displacement of the tibial tuberosity (MADD) is a comprehensive realignment osteotomy designed to correct patellar height, alignment, and contact mechanics. This study aimed to evaluate radiographic, clinical, and functional outcomes of MADD in patients with multifactorial patellar instability.
Materials and Methods: Twenty-six patients (30 knees) with recurrent patellar instability associated with patella alta, trochlear dysplasia (Dejour types B–D), and elevated TT–TG distance underwent MADD. The mean age at surgery was 23.5 years (range, 16–35 years), with a minimum of one-year follow-up. Radiographic assessment included TT–TG distance and Caton–Deschamps Index (CDI). Clinical outcomes were evaluated using the Kujala score, Tegner activity scale, and apprehension test. Complications such as redislocation, nonunion, and hardware irritation were documented. The MADD technique was performed by creating a mobile tibial tuberosity fragment through a specifically tailored osteotomy, followed by controlled medialization, anteriorization, and distalization of the fragment to correct excessive lateralization, normalize patellar height, and improve patellofemoral joint mechanics. Fixation was achieved with screws. Postoperative rehabilitation consisted of 2 weeks of immobilization, with progression to full weight-bearing at 4 weeks, followed by range-of-motion and strengthening exercises.
Results: At a mean follow-up of 3.1 years, the average preoperative TT–TG distance was 20.4 mm (range, 16–28 mm). CDI significantly improved from 1.40 (range, 1.2–1.6) to 0.96 (range, 0.9–1.1) ($P < 0.01$). The mean Kujala score increased from 62.2 to 93.0 ($P < 0.01$), and the Tegner activity level improved from 2.7 to 4.7 ($P < 0.05$). The apprehension test became negative in 93.3% of knees.
No redislocations or osteotomy nonunions occurred. Three patients (10%) experienced mild screw irritation or prominence of the transferred fragment, which resolved after implant removal. One patient with severe trochlear dysplasia (Dejour type D) and a large trochlear bump required secondary trochleoplasty for persistent symptoms. No infections, fractures, or major complications were observed.
Conclusion: MADD provided significant radiographic correction and excellent clinical improvement in patients with multifactorial patellar instability. By enabling controlled medial, anterior, and distal repositioning of the tibial tuberosity fragment, the procedure effectively normalized patellar height, reduced TT–TG distance, and improved patellofemoral mechanics, resulting in favorable functional outcomes and no redislocations in this cohort. These findings support the use of MADD as an effective realignment option for cases in which isolated MPFL reconstruction may be insufficient. However, the need for secondary trochleoplasty in a patient with a pronounced trochlear bump suggests that MADD may have limitations in the presence of substantial trochlear deformity, underscoring the importance of careful surgical indication and further investigation of its applicability in such complex anatomical conditions.

OS16-1

The Presence or Absence of Cartilage Regeneration Following Medial Open-Wedge High Tibial Osteotomy Does Not Predict Long-term Outcomes

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Purpose
To assess whether the patients who showed mature cartilage regeneration in the medial compartment in a second-look arthroscopy have better clinical and radiologic long-term outcomes and survivorship compared to immature cartilage regeneration following medial open-wedge high tibial osteotomy (MOWHTO).
Methods
Patients who underwent MOWHTO using a medial locked plate system were retrospectively reviewed between February 2008 and December 2012. All included patients had no concomitant cartilage-restoring procedures, underwent second-look arthroscopy at 2 years postoperatively, and were followed for at least 10 years. Based on arthroscopic findings in the medial femoral condyle, patients were classified into mature and immature cartilage regeneration groups. Clinical outcomes, including the primary outcome of the total Western Ontario and McMaster Universities Osteoarthritis Index score, were compared between the groups using patient-reported outcome measures. The minimal clinically important difference (MCID) was assessed to determine clinical significance. Radiologic progression of osteoarthritis was evaluated using serial changes in the Kellgren-Lawrence grade, and survivorship, defined as conversion to arthroplasty, was analyzed using the Kaplan-Meier method.
Results
A total of 83 consecutive knees were included, with 34 in the mature group and 49 in the immature group. The mean follow-up period was 12.1 years (range, 10-15.2 years). No significant differences were observed in clinical outcomes or the proportion of patients achieving the MCID on the Western Ontario and McMaster Universities Osteoarthritis Index scale (MCID 9.1; group M 93.9% vs group I 97.9%, P = .564). Radiologic progression showed a trend of progressing more slowly in the mature group than in the immature group without significance at the latest follow-up (P = .113). The 10-year survival rate was 100% in the mature group and 95.6% in the immature group (P = .099).
Conclusions
The presence or absence of cartilage regeneration in the medial compartment does not predict better long-term outcomes, including radiologic progression, the achievement of MCID in clinical outcomes, or survivorship following MOWHTO.

OS16-2

Arthroscopic Microdrilling for Full-thickness Trochlear Cartilage Defects in Patients Undergoing High Tibial Osteotomy Confers Improved Cartilage Status at 1 year and Rate of Minimal Clinically Important Difference at Short-term Follow-up.

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Purpose: To compare the patient-reported outcome improvements and cartilage status of trochlear cartilage defects (TCDs) after additional arthroscopic microdrilling versus no treatment for TCDs during medial open-wedge high tibial osteotomy(MOWHTO)
Methods: Patients who underwent MOWHTO with either microdrilling (Group M) or no treatment (Group N) for near full-thickness TCDs (International Cartilage Repair Society[ICRS] grade≥3B) from March 2010 to September 2022 were retrospectively reviewed, with a minimum 2-year follow-up. 1:1 Propensity score matched-Group N was created. Comparative analyses were conducted using patient-reported outcomes(PROs) and minimal clinically important difference (MCID). Trochlear cartilage status was visually assessed via second-look arthroscopy 1 year postoperatively and categorized as deteriorated, maintained, or improved.
Results: Overall, 30 for group M and 84 patients for group N were included. The mean follow-up period of the matched groups was 32.8 and 32.0 months for groups M and N. The preoperative and postoperative radiographic parameters did not differ between the groups (Kellgren-Lawrence grade, pre- and postoperative alignment, medial proximal tibia angle). Both groups achieved significant clinical improvement in patients with medial compartment osteoarthritis and combined full-thickness TCD ($p<0.001$). PROs and improved PROs at final follow-up were not significantly different between groups, except for the Final Kujala anterior knee pain scale (70.4 [95% CI: 66.0–74.8] vs. 59.8 [95% CI: 53.0–67.6], p=0.018). MCID achievement rates in pain visual analogue scale (VAS), Knee injury and Osteoarthritis Outcome Scores (KOOS)-Pain, and KOOS-activity of daily living (ADL) were significantly higher in group M compared to group N (VAS, 93.3% vs. 63.3%, p=0.005; KOOS-Pain, 96.7% vs. 80.0%, p=0.044; KOOS-ADL, 86.7% vs. 63.3%, p=0.037). A significantly larger proportion of patients in group M demonstrated improvement in their TCD status compared to those in group N (93.1% vs. 44.8%, $p<0.001$).
Conclusion: Arthroscopic microdrilling for near full-thickness TCD during MOWHTO improved trochlear cartilage status at 1 year but did not enhance final PROs at short-term follow-up, though it increased MCID achievement rates in some PROs (VAS, KOOS pain, KOOS ADL) compared to untreated patients.

OS16-3

Adding Cartilage Repair to High Tibial Osteotomy Does Not Improve 10-Year Clinical Outcomes: A Comparative Study of HTO Alone, with Micro-Drilling, and with OATS

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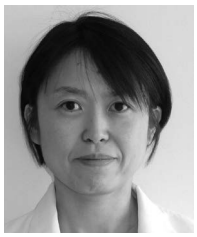
-Purpose : To determine if adding a cartilage repair procedure (micro-drilling or OATS) to a high tibial osteotomy (HTO) improves long-term clinical outcomes or 10-year survivorship compared to HTO alone.
-Material and Methods : This retrospective comparative study reviewed patients who underwent medial opening-wedge high tibial osteotomy (MOWHTO) for symptomatic medial compartment osteoarthritis with varus malalignment between 2009 and 2015. Patients were stratified into three treatment groups: MOWHTO alone, MOWHTO with subchondral micro-drilling, and MOWHTO with OATS. Outcomes were assessed using the Knee Society Score (KSS), KSS Function Score (KSSF), and Oxford Knee Scores (OKS) over a minimum follow-up period of 10 years. Analysis of the Minimal Clinically Important Difference (MCID) was also performed. Failure was defined as conversion to total knee arthroplasty.
-Results : A total of 108 patients were included. At a minimum 10-year follow-up (mean 12.4 years and range 10-15 years), there were no statistically significant differences in the mean KSS($p=0.38$), KSSF($p=0.17$), and Oxford Knee Scores($p=0.29$) among the three groups. A high proportion of patients in all groups achieved the MCID for KSS (88-92%) and KSSF (84-89%), with no significant difference between the groups ($p > 0.05$). Survivorship was slightly higher in the OATS group (97.06%) compared to HTO alone (90.48%) and HTO with drilling (93.75%), but this was not statistically significant ($p = 0.51$). Four patients in Group A, two in Group B, and one in Group C required TKA during follow-up.
-Conclusion : At a minimum 10-year follow-up, adding subchondral micro-drilling or OATS to a high tibial osteotomy does not result in significantly improved mean clinical outcomes, nor does it increase the proportion of patients achieving a clinically meaningful improvement. While a non-significant trend toward better survivorship was observed with OATS, the routine addition of these adjunctive procedures may not be justified Level of Evidence: Level III, Retrospective comparative study.

OS16-4



Mid-Term MRI Assessment of Meniscal and Cartilage Changes After Medial Opening-Wedge High Tibial Osteotomy

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-Introduction/Purpose
Medial opening-wedge high tibial osteotomy (OWHTO) improves medial compartment cartilage and alignment in the short term; however, it's mid- to long-term effects on the meniscus and cartilage remain uncertain. This study aimed to evaluate changes in the medial meniscus and cartilage on MRI up to nine years after OWHTO. It was hypothesized that OWHTO would maintain cartilage quality and suppress meniscal extrusion over time.
-Material and Methods
Twenty-four knees that underwent OWHTO for medial osteoarthritis or osteonecrosis were reviewed. Among these, five knees received additional microfracture (MF) for extensive cartilage defects, seven underwent partial medial meniscectomy for degenerative flap tears, and five with medial meniscus posterior root tear (MMPRT) were left untreated. Radiographic and MRI evaluations were performed preoperatively, early term (1–2 years), and mid-term (5–9 years). Radiographic parameters included the mechanical axis percentage (%MA) and medial proximal tibial angle (MPTA). MRI analyses included the MOCART score, T2 relaxation times of the medial femoral condyle (MFC) and tibial plateau (MTP), and medial meniscus extrusion (MME).
-Results
Radiographs showed a %MA improvement from 32% to 62% and an MPTA correction from 85° to 92° at mid-term follow-up. The MOCART score was maintained from early to mid-term, indicating preservation of cartilage repair status. The lowest total and subchondral bone scores were observed in the MF group, while the "volume" subscore was reduced in both MF and meniscectomy cases.
T2 relaxation times in the MFC and MTP decreased significantly ($P < .05$), suggesting improved cartilage organization. However, in the MF subgroup, T2 values tended to increase toward the mid-term, indicating deterioration of repair tissue quality over time despite initial improvement. MME did not differ statistically between groups, but two cases showed improvement. In the meniscectomy group, MME increased from 5.9 ± 1.7 mm preoperatively to 7.3 ± 2.5 mm at the mid-term. In contrast, the unresected group showed more stable values: 3.6 ± 2.1 mm preoperatively, 4.9 ± 1.8 mm early, and 4.3 ± 3.3 mm at mid-term follow-up.
-Conclusion
Mid-term MRI evaluation indicated that OWHTO maintained corrected alignment and preserved cartilage condition in the medial compartment. Cartilage quality was generally stabilized, though not completely restored. Concomitant meniscectomy or MF for large cartilage defects resulted in lower MOCART scores and greater meniscal extrusion. These findings suggest that tissue preservation or reconstruction may contribute to better long-term chondroprotective outcomes after OWHTO.
Conflict of Interest: The authors declare that there are no conflicts of interest.

OS16-5

Combined autologous chondrocyte implantation and high tibial osteotomy for large cartilage lesions in elderly patients with spontaneous osteonecrosis of the knee

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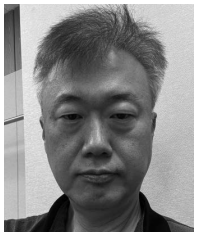
Introduction/Purpose:
This study aimed to evaluate the clinical and histological outcomes of autologous chondrocyte implantation (ACI) combined with high tibial osteotomy (HTO) in elderly patients with spontaneous osteonecrosis of the knee (SONK) presenting with relatively large cartilage defects.
Material and Methods:
Eleven knees of 11 patients (mean age, 68.9 years; lesion size ≥4 cm^2) with SONK underwent atelocollagen-associated ACI and concomitant medial opening-wedge HTO. All patients were followed for at least one year postoperatively. Clinical outcomes were assessed using the Knee injury and Osteoarthritis Outcome Score (KOOS). Cartilage repair was evaluated arthroscopically according to the International Cartilage Repair Society (ICRS) repair grade and histologically using the ICRS II scoring system at second-look arthroscopy performed at the time of plate removal. Statistical analyses were performed using nonparametric tests, with significance set at $p < 0.05$.
Results:
All patients completed rehabilitation without major complications or additional surgery. The mean KOOS overall score significantly improved from 38.4 ± 8.5 preoperatively to 77.8 ± 10.9 at one year postoperatively ($p < 0.01$). The mean hip–knee–ankle angle improved from −6.0 ± 2.2° to 4.5 ± 2.0° ($p < 0.01$). Arthroscopic evaluation revealed normal or nearly normal cartilage repair (ICRS grade 1 or 2) in 91% of knees, showing white, smooth cartilaginous tissue with full defect coverage. Histological analysis demonstrated a mean ICRS II overall score of 67.5 ± 16.2, characterized by hyaline-like cartilage containing round or oval chondrocyte-like cells and strong safranin O staining in the mid-to-deep zone, indicating sufficient glycosaminoglycan content and integration with subchondral bone. All tissue-engineered cartilage implants met sterility and viability standards before implantation.
Conclusions:
ACI combined with opening-wedge HTO yielded favorable short-term clinical, arthroscopic, and histological outcomes in elderly patients with SONK and large cartilage defects. These results demonstrate that ACI is feasible even in patients aged 60 years or older. The combination of mechanical realignment by HTO and biological cartilage restoration by ACI appears to provide synergistic benefits for joint preservation in this challenging patient group.

Oral Presentation 17 AKO and cartilage 2

OS17-1



Treatment of osteoarthritic knee with high tibial osteotomy and allogeneic human umbilical cord blood–derived mesenchymal stem cells combined with hyaluronate hydrogel composite

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-Introduction/Purpose: Delaying total knee arthroplasty is crucial for middle-aged patients with severe osteoarthritis. The long-term outcomes of high tibial osteotomy (HTO) remain uncertain. Recently, mesenchymal stem cells (MSCs) have shown promising potential in enhancing cartilage regeneration. Therefore, this study aimed to assess cartilage regeneration following the implantation of allogeneic human umbilical cord blood–derived mesenchymal stem cells (hUCB-MSCs) with HTO.
-Material and Methods: In this case series, ten patients underwent hUCB-MSC implantation with HTO. The median age was 58.50 (range: 57.00–60.00) years, and the mean body mass index was 27.81 (range: 24.42–32.24) kg/m2. Clinical outcomes, including the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), visual analog scale (VAS),
Physical Component Score (PCS) and Mental Component Score (MCS) from the 36-Item Short-Form Health Survey (SF-36), were evaluated 6 months, 1 year, and 2 years postoperatively. Cartilage status of the medial femoral condyle (MFC) was assessed during hardware removal surgery, at least 2 years after the initial procedure, and compared
with preoperative MFC cartilage status regarding lesion size and International Cartilage Repair Society (ICRS) grade. Radiological assessments included the Kellgren–Lawrence (KL) grading system for medial compartment osteoarthritis and hip–knee–ankle (HKA) angle.
-Results: Significant improvements were observed in WOMAC scores (preoperative: 57.00 (range: 44.75–63.00), postoperative: 27.50 (range: 22.25–28.75)), VAS scores (preoperative: 66.25 (range: 48.00–74.25), postoperative: 26.25 (range: 14.50–31.13)), SF-36 PCS (preoperative: 27.97 (range: 26.64–31.25), postoperative: 55.31 (range: 51.64-62.50)), and SF-36 MCS (preoperative: 41.04 (range: 29.95–50.96), postoperative: 63.18 (range: 53.83–65.16)) 2 years postoperatively ($p = 0.002$, 0.002, 0.002, and 0.020, respectively). The MFC chondral lesion demonstrated significant improvement in both lesion size (preoperative: 7.00 cm^2 (range: 4.38–10.50 cm^2), postoperative: 0.16 cm^2 (range: 0.00–1.75 cm^2), $p = 0.002$) and ICRS grade (preoperative: 4 (range: 4–4), postoperative: 1 (range: 1–2.25), $p = 0.002$).
Additionally, the KL grade significantly decreased from 3 (range: 3–3) preoperatively to 2 (range: 2–2) postoperatively, while the HKA angle was corrected from 7.50° (range: 7.00–10.25°) preoperatively to -1.00° (range: -3.5–0.00°) postoperatively.
-Conclusion: hUCB-MSC implantation with HTO is an effective treatment for medial compartment osteoarthritis and varus deformities, resulting in significant improvements in cartilage regeneration and overall clinical outcomes

OS17-2

Long-term outcomes after autologous chondrocyte cell-sheet transplantation combined with high tibial osteotomy for osteoarthritis of the knee

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-Introduction/Purpose: Autologous chondrocyte transplantation has shown promising short-term results for focal cartilage defects, but long-term data in osteoarthritis of the knee (OAK) are scarce. In earlier clinical studies, autologous chondrocyte cell-sheet (AC sheet) transplantation combined with high tibial osteotomy (HTO) demonstrated significant improvements in knee function and histological evidence of hyaline-like cartilage regeneration at 1 year, with results maintained up to 3 years postoperatively (NPJ Regen Med. 2019). Despite these encouraging early outcomes, the durability of AC sheet transplantation over the long term remains unknown. Determining whether biologically augmented joint-preserving surgery can provide sustained functional and structural benefits is essential to validate this treatment for younger and active patients with OAK. Therefore, the purpose of this study was to evaluate the 10-year clinical, radiographic, and functional outcomes of AC sheet transplantation combined with HTO.
-Material and Methods: Four patients (2 men, 2 women; mean age, 54.5 ± 3.7 years) underwent AC sheet transplantation between 2011 and 2013 combined with HTO. Primary outcomes included the Lysholm Knee Score (LKS) and the Knee injury and Osteoarthritis Outcome Score (KOOS). Secondary outcomes included radiographic assessment using the Kellgren-Lawrence (K-L) grading system on standardized anteroposterior and lateral radiographs. Comparisons between 3- and 10-years outcomes were performed using paired t-tests or Wilcoxon signed-rank tests.
-Results: Mean LKS decreased from 97 ± 2.3 at 3-years to 82.3 ± 14.6 at 10-years. There was no significant difference between 3- and 10-years, however, one patient markedly worsened due to systemic illness. KOOS were Symptom 95.5±1.7, Pain 97.8±2.9, ADL 98±1.4, Sport/Rec 88.8±11.1, QOL 81.3±5.3 at 3-years, and Symptom 92.8±9.6, Pain 88.8±9.8, ADL 94.5±6.4, Sport/Rec 66.3±26.3, QOL 75.1±13.5 at 10-years. All subscales demonstrated non-significant decreases between 3- and 10-years. Radiographic evaluation demonstrated progression of K-L grade in one of four patients. At 3-years, four knees were grade 3. At 10-years, three remained at grade 3, and one progressed to grade 4.
-Conclusion: This study represents one of the first reports to evaluate the 10-year clinical course following AC sheet transplantation combined with HTO. Overall, functional outcomes measured by the LKS and KOOS were significantly improved from baseline and largely maintained over a decade. Radiographic progression was limited. Importantly, clinical deterioration was observed only in patient with systemic illness. AC sheet transplantation demonstrated favorable 10-year outcomes and safety, suggesting that biological augmentation may enhance joint-preserving surgery.

OS17-3

Incidence and Clinical Significance of Cartilage Hypertrophy After Costal Chondrocyte-Derived Pellet-Type Autologous Chondrocyte Implantation: A Preliminary MRI-Based Study

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Introduction/Purpose:
Autologous chondrocyte implantation (ACI) has evolved from periosteal-covered to matrix-assisted techniques, achieving promising long-term outcomes. Recently, a new-generation, scaffold-free pellet-type ACI using costal chondrocytes (CCP-ACI, CartiLife®) has been introduced in Korea, offering easier harvest and faster regeneration compared to traditional articular cartilage–derived ACI. However, postoperative cartilage hypertrophy remains a debated issue, with its incidence and clinical relevance yet to be fully elucidated. This study aimed to evaluate the frequency and characteristics of graft hypertrophy following CCP-ACI based on postoperative MRI (MOCART scoring).
Materials and Methods:
We retrospectively reviewed 33 patients (64 lesions) who underwent CCP-ACI for focal cartilage defects of the knee between 2021 and 2024 at a single center by three attending surgeons. The chondrocytes were isolated from autologous costal cartilage, cultured for 6–7 weeks, and implanted arthroscopically under air insufflation. MRI evaluations were performed at 6 months, 1 year, and 2 years postoperatively. Hypertrophy was defined as overfilling of the repair tissue exceeding the surrounding native cartilage height on MOCART scoring. Clinical outcomes were assessed using Lysholm, IKDC, and KOOS scores.
Results:
Among 33 patients with 64 treated lesions, MRI-defined hypertrophy was observed in 22 lesions (34.4%). The temporal and anatomical distribution demonstrated a characteristic pattern: at 6 months, hypertrophy appeared predominantly in the patellofemoral joint—particularly at the patella and trochlea—whereas by 2 years, hypertrophic changes were more frequently identified at the lateral femoral condyle. Hypertrophy tended to occur in non–weight-bearing regions, suggesting that its development is influenced more by the intrinsic biological activity of costal chondrocytes than by mechanical loading.
A subset of patients with patellofemoral hypertrophy developed mechanical symptoms, such as clicking, catching, or transient patellar maltracking due to a protruding hypertrophic bump. In these symptomatic cases, arthroscopic debridement of the hypertrophic tissue was performed with satisfactory resolution of symptoms.
Overall, patients demonstrated substantial postoperative improvement in functional outcomes. When outcomes were compared between hypertrophy-positive and hypertrophy-negative groups, there were no significant differences in key functional PROMs, including Lysholm and IKDC scores. However, VAS pain showed a distinct trajectory: while pain improvement was similar up to 1 year, the hypertrophy-positive group exhibited a notable increase in pain at 2 years, a pattern not observed in the non-hypertrophy group. This suggests that persistent hypertrophy may contribute to delayed-onset pain despite preserved functional recovery.
Conclusions:
Cartilage hypertrophy occurred in about one-third of lesions after costal chondrocyte–derived pellet-type ACI, appearing early in the patellofemoral joint and later at the lateral femoral condyle, often in non–weight-bearing areas. Although functional recovery was similar regardless of hypertrophy, some patients developed late-onset pain or patellofemoral mechanical symptoms requiring debridement. Further follow-up is needed to determine which cases represent benign maturation versus clinically significant hypertrophy.

OS17-4

Changes in MRI Findings Following High Tibial Osteotomy in Patients with Knee Osteoarthritis

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-Introduction/Purpose
High tibial osteotomy (HTO) is a surgical procedure that relieves pain by correcting lower limb alignment. However, few studies have reported changes in magnetic resonance imaging (MRI) findings associated with osteoarthritis (OA) after HTO. This study aimed to elucidate the effects of HTO on bone marrow lesions (BMLs), cartilage, and medial meniscal extrusion (MME) in patients with medial knee OA.
-Material and Methods
A total of 32 knees in 24 patients (13 men, 11 women) who underwent opening wedge HTO for medial knee OA and had available MRI evaluations were included. The mean age was 62 ± 8 years, and the Kellgren–Lawrence grades were II in 3 knees, III in 15, and IV in 14. The mean interval between HTO and hardware removal was 22 ± 6 months. Pain at rest and during walking was evaluated using a visual analog scale (VAS, mm) before and after surgery. On MRI, the area of BMLs (in the medial femoral condyle, medial tibial plateau, and total), cartilage status of the medial compartment assessed by the Whole-Organ Magnetic Resonance Imaging Score (WORMS), and the degree of MME were compared between preoperative and postoperative images.
-Results
VAS scores improved significantly from 48 mm to 10 mm during walking and from 17 mm to 4 mm at rest. The BML area significantly decreased in all regions: medial tibial plateau, 56 → 13 mm²; medial femoral condyle, 57 → 18 mm²; total, 145 → 33 mm². Cartilage status of the medial compartment showed no significant improvement. The degree of MME significantly improved from 5.5 mm to 4.2 mm.
-Conclusion
Postoperative MRI evaluations revealed significant reductions in BML area and MME following HTO. These findings suggest that the pain relief achieved after HTO may not only result from correction of limb alignment but also from the reduction of BMLs and improvement of meniscal extrusion.

OS17-5

Mid-term Clinical Outcomes of Around the Knee Osteotomy with Iliac Bone Grafting for Large Osteochondral Defect in the Weight-Bearing Region

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【Purpose】
To report the mid-term clinical outcomes of patients who underwent around the knee osteotomy (AKO) with iliac bone grafting (IBG) for large osteochondral defects in the weight-bearing region of the knee joint.
【Material and Methods】
The subjects were 10 knees who underwent AKO with IBG (AKO+IBG group) for large osteochondral defects in the weight-bearing region between April 2014 and March 2021. The AKO included conventional high tibial and/or distal femoral osteotomy. The IBG involved harvesting a full-thickness bone block including the iliac crest, shaping it so the iliac crest portion formed the weight-bearing surface, and fixing it to the defect site. For comparison, 51 knees who underwent AKO (AKO group) during the same period served as the control group. The evaluation parameters included follow-up duration, age, body mass index (BMI), preoperative femorotibial angle (FTA), osteochondral defect area and volume, and improvement (postoperative minus preoperative scores) in Knee injury and Osteoarthritis Outcome Score (KOOS) scores. The KOOS scores evaluated were Symptom, Pain, ADL, Sports, and QOL.
【Results】
In the AKO+IBG group, the mean follow-up duration was 74.6 months. The mean values for age, BMI, preoperative FTA, osteochondral defect area, volume, and improvement in KOOS scores were 60.1 years, 25.3 kg/m2, 177.0 degrees, 507 mm^2, 7092 mm^3, Symptom 23.9, Pain 32.3, ADL 16.8, Sports 25.5, and QOL 29.4, respectively. In the AKO group, the mean follow-up duration was 58.6 months. The mean values for age, BMI, preoperative FTA, and improvement in KOOS scores were 61.2 years, 25.8 kg/m2, 181.9 degrees, Symptom 21.9, Pain 27.5, ADL 21.0, Sports 30.4, and QOL 41.0, respectively. No significant differences were observed between the AKO+IBG group and the AKO group for any of these parameters.
【Conclusion】
The AKO+IBG group demonstrated favorable mid-term clinical outcomes at an average of 74.6 months for large osteochondral defects in the weight-bearing region of the knee joint, achieving postoperative outcomes comparable to those of the AKO group. This study suggests that IBG may be an effective treatment option for large osteochondral defects in weight-bearing region of the knee joint.

Oral Presentation 18 Hinge fracture and ankle

OS18-1

Obesity does not negatively impact early clinical outcomes of medial opening high tibial osteotomy in the Asian Population

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Introduction: High tibial osteotomy (HTO) is a well-established joint-preserving procedure for medial compartment osteoarthritis associated with varus malalignment. While obesity has been linked to inferior outcomes in total knee arthroplasty, its effect on HTO remains debated, with most evidence derived from Western cohorts. This study aimed to evaluate the influence of body mass index (BMI) on clinical outcomes, complications, and survivorship following HTO in an Asian population.
Methods: We conducted a retrospective cohort study of 213 consecutive patients who underwent HTO for medial compartment osteoarthritis between 2019 and 2024. Patients were stratified into BMI categories (<27.5 vs ≥27.5 kg/m², WHO Asian classification) and compared across demographics, patient-reported outcome measures (PROMs), complications, and conversion to total knee replacement (TKR). PROMs were assessed using the Knee Society Score (KSS) and Oxford Knee Score (OKS) preoperatively, at six months, and at 2 years.
Results: A total of 210 patients were included, with a mean age of 53.8 ± 8.8 years. Both normal-weight and high-BMI groups demonstrated significant improvements in KSS and OKS from baseline to 24 months (all $p < 0.001$). At six months, the low-BMI group had superior KSFS (77.7 ± 20.3 versus 68.8 ± 19.5, $p < 0.05$), but differences were not sustained at final follow-up of 2 years ($p > 0.05$). No significant differences were observed in complication rates, radiological correction, or conversion to TKR between groups.
Conclusion: HTO provides substantial and durable clinical improvement in both normal-weight and obese patients. While obese patients may present with worse preoperative status and slower short-term recovery, mid-term outcomes and survivorship are comparable. BMI alone should not be considered a contraindication for HTO in appropriately selected patients.

OS18-2

Optimizing Lateral Hinge Stability in Medial Open-Wedge High Tibial Osteotomy: The Role of Hinge Hole and Protective K-Wire

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-Introduction/Purpose
Lateral hinge fracture (LHF) remains a major complication in medial open-wedge high tibial osteotomy (MOWHTO), often jeopardizing bone healing, joint stability, and overall surgical success. Current strategies such as hinge holes and protective K-wires aim to mitigate LHF by, respectively, reducing stress concentration at the hinge and reinforcing lateral cortical stability. This study investigates the combined effect of hinge holes and protective K-wires on minimizing lateral cortical stress and preventing LHF during MOWHTO.
-Material and Methods
A hybrid approach integrating finite element analysis (FEA) and in-vitro compression testing was employed to evaluate stress distribution and fracture mechanisms. Three-dimensional tibial models reconstructed from osteoarthritic CT data were used for both simulations and tests, ensuring geometric consistency in wedge, hinge, and K-wire positioning. To ensure cost-effectiveness and reproducibility, physical test models were fabricated via 3D printing. FEA assessed stress evolution during wedge opening, while compression testing provided loading–gap relationships, fracture loads, and failure patterns.
-Results
Introducing hinge holes reduced hinge stress concentration by 14.4% and decreased peak loading by 34% relative to standard models. Protective K-wires alone enhanced maximum loading capacity by 48–60% but increased the likelihood of Type III fractures, especially at corrections exceeding 10 mm. The combined use of hinge holes and K-wires significantly mitigated this risk, lowering Type III LHF incidence to 11.1%, compared with 16.7% for hinge holes alone and 77.8% for K-wires alone. Furthermore, lateral cortical stress was reduced by 22% with the combined technique.
-Conclusion
The integration of hinge holes and protective K-wires offers an optimized biomechanical strategy for MOWHTO, balancing load redistribution with enhanced lateral hinge stability. This combined method effectively decreases the risk of Type II and III LHFs, providing a robust foundation for clinical translation and emphasizing the importance of precise surgical registration for optimal outcomes.

OS18-3

Opposite Lag Screw as an Adjunct in High Tibial Osteotomy with Lateral Hinge Fracture: Improved Union and Correction Maintenance

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Purpose
Lateral hinge fracture (LHF) is a common complication of medial open-wedge high tibial osteotomy (MOWHTO), associated with an elevated risk of nonunion and loss of correction. This study investigated whether the addition of an opposite lag screw placed laterally across the hinge could reduce nonunion and improve correction maintenance.
Methods
This retrospective study included patients who underwent MOWHTO for knee osteoarthritis by a single surgeon between May 2016 and May 2023 at a single center. Exclusion criteria included concomitant anterior cruciate ligament or meniscus repair, cosmetic surgery, and follow-up less than one year. Patients were divided into screw and no-screw groups, with 1:1 case–control matching based on age (±5 years), sex, and fracture type. Radiographic outcomes included weight-bearing line (WBL) ratio, hip–knee–ankle angle, femorotibial angle, medial proximal tibial angle, posterior tibial slope angle, and union time. Correction accuracy was defined as planned (WBL 57–67%), acceptable but unplanned (50–70%), or inappropriate (<50% or >70%). Complications and reoperations were also recorded.
Results
Eighty knees were analyzed (40 screws and 40 no screws). The mean follow-up period was 31 and 53 months in the screw and no-screw groups, respectively. At the final follow-up, correction was significantly better in the screw group. Planned correction was achieved in 15 screw knees versus 4 without (P = 0.0075). Inappropriate correction was less frequent in the screw group (15 vs. 25, P = 0.026). Nonunion occurred exclusively in the no-screw group (five knees). Reoperation rates were higher in the no-screw group than that in the screw group (eight vs. five revision HTOs; and three vs. no conversions to total knee arthroplasty).
Conclusions
The addition of an opposite-lag screw is a simple and practical adjunct that reduces nonunion and enhances correction maintenance in patients with LHF following MOWHTO.

OS18-4

Underestimated incidence of acute lateral hinge fractures in medial opening wedge high tibial osteotomy: The role of MRI in early detection

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-Objective : 1) Investigate the incidence of lateral-hinge fractures after medial opening wedge high tibial osteotomy using MRI postoperatively alongside radiographs. 2) Determine the number of missed acute lateral-hinge fractures and distinguish them from true delayed fractures 3)Evaluate the complications associated with these fractures.
-Methods : This retrospective study analyzed 250 knees from 227 patients who underwent medial opening-wedge high tibial osteotomy. Radiological evaluation was performed using radiographs, CT scans, and MRI. Patients were categorized into four groups: (1) Acute Lateral-hinge fractures, (2) missed Lateral-hinge fractures, (3)delayed Lateral-hinge fractures and (4) no fractures.
-Results : MRI detected lateral hinge fractures (LHF) in 59.6 % of cases, nearly doubling the detection rate of radiographs and CT scans (33.2 %), revealing a significant underestimation of LHF in MOWHTO. Additionally, 73.49 % of presumed delayed fractures were actually missed acute fractures, with a true delayed fracture incidence of only 1.6 %. The fracture groups had a longer healing time and were associated with a loss of correction.
-Conclusion : The incidence of lateral-hinge fractures after medial opening-wedge high tibial osteotomy is significantly underestimated, with most occurring intra-operatively but often missed on postoperative radiographs and misclassified as delayed fractures. MRI, highly sensitive for early detection and prevention of misclassification, helps optimize rehabilitation strategies and improve patient outcomes.

OS18-5

MRI-Based Classification of Lateral Hinge Fractures: A Timely Necessity

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-Purpose : To investigate this variant of Takeuchi type 1 fracture and its outcome, as well as to develop an MRI classification based on the fracture line pattern.
-Methods : This retrospective study analyzed 250 knees from 227 patients (169 females, 58 males) who underwent MOWHTO. Fractures were detected using MRI and classified into four types based on the fracture line pattern: Type A (proximal to the tibiofibular joint), Type B (into the proximal tibiofibular joint), Type C (distal to the tibiofibular joint), and Type D (proximal into the joint). Patients were followed-up with radiographs and CT scans to monitor outcome.
-Results : Type A fractures had a shorter union time (3.66 months) than Type B (5.17 months), Type C (6.24 months), and Type D (5.75 months). Type B had a delayed union rate of 20%, higher
than type A(2.46%). Statistical analysis confirmed that Type A fractures had significantly better outcomes than Types B, C, and D. Type B fractures are by definition Takeuchi type I fractures, but exhibit clinical characteristics similar to type II fractures, including longer union times and a higher risk of delayed union.
-Conclusion : MRI provides superior detection rates for acute fractures and enables earlier identification of fracture patterns compared to radiographs. Takeuchi type I has two subtypes (A and B). Type B fracture has clinical similarities to Takeuchi type II fractures, whereas type A fracture has union rates similar to those in non-fracture groups. 90% of type B fractures identified on MRI will be visible on follow-up radiographs and should be managed similarly to Takeuchi type II fractures.

OS18-6

Distal Tibial Oblique Osteotomy for Stage 4 Ankle Osteoarthritis

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Introduction:
End-stage ankle osteoarthritis (AOA, stage 4) is characterized by global joint-space narrowing with bone-to-bone contact. Although ankle arthrodesis (AA) or total ankle replacement (TAR) are generally indicated, there is no clear consensus regarding optimal management. We have performed distal tibial oblique osteotomy (DTOO) for stage 4 AOA cases with preserved ankle motion, but few reports have focused on such advanced cases.
Purpose:
To evaluate the clinical and radiographic outcomes of DTOO for stage 4 AOA with preserved ankle motion.
Material and Methods:
We retrospectively analyzed patients with stage 4 AOA who underwent DTOO and had ankle range of motion ≥15°. The osteotomy was performed according to Teramoto's procedure, with intraoperative fluoroscopy to assess varus–valgus instability and to achieve optimal tibiotalar congruency in the lateral view. Radiographic parameters (TAS : tibial articular surface angle, TTA : talar tilt angle, TTS : tibiotalar surface angle, TLS : tibial lateral surface angle) were measured pre- and postoperatively. Clinical outcomes were evaluated using the Japanese Society for Surgery of the Foot (JSSF) ankle-hindfoot scale. Statistical significance was set at $p<0.05$.
Results:
Fifteen ankles (3 men, 12 women; median age, 70 years; mean follow-up, 40 months) were included. Fixation was achieved with an Ilizarov external fixator in 11 cases and a locking plate in 4. Postoperatively, TAS, TTS, and TLS significantly increased, while TTA showed no significant change. The JSSF score improved significantly from 34.7±14.6 to 85.5±7.0 ($p<0.05$).
Conclusion:
DTOO can provide pain relief and functional improvement in stage 4 AOA cases with preserved motion by restoring joint congruency and dynamic stability. It represents a valuable joint-preserving option for selected end-stage AOA patients.

OS18-7

Distal Tibial Oblique Osteotomy (DTOO) : Surgical technique and clinical varus ankle osteoarthritis

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-Introduction/Purpose

We developed the Distal Tibial Oblique Osteotomy :DTOO and have used this technique since 1994 for mild, moderate and severe varus ankle OA.The purpose of this report is that the surgical technique and clinical results of DTOO for varus ankle OA.

-Material and Methods

The study cohort comprised 60 ankles with varus ankle OA who were treated with DTOO. The osteotomy line of DTOO was designed starting from approximately 5 cm proximal to the distal tibial medial malleolus and extending to the center of the distal tibiofibular joint without the cut of fibula. The osteotomy gap was spread until the lateral articular surface of the talus comes into contact with the medial articular surface of the fibula. Ilizarov external fixator or the plate were fixed and the iliac bone was grafted,

The average age of these cases was 62.7years.Primary ankle OA was47 ankles ,traumatic ankle OA was 13 ankles. Primary ankle OA was classified used by Tanaka,s classfication for ankle OA, 2 ankles as stage2, 6 ankles as stage 3a and 28 ankless as stage 3b, 11 ankles as stage 4. The average follow up periods were 42.2 mos.We evaluated the clinical results using the JSSF scale before and after the operation. On a 100-point system, points were allocated as follows: 40 points for pain and walking ability, 50 points for function, 10 points for alignmnet. An anteroposterior (AP) view of the roentgenogram of the ankle joint (standing position) was performed for the radiological evaluation. TAS(tibial articular surface angle),MMA(medial malleolar angle),TTA(talar tilt angle),TTS(tibiotalar surface angle),TLS(tibial lateralsurface angle) were measured. And also, The varus stress angle and valgus stress angle were measured as the angle between the tangential line of the and the articular surface of the tibial plafond in varus and valgus stress radiographs under the image intensifier .The total amplitude of the varus stress angle and valgus stress angle was identified as the ankle joint instability angle (AJIA).

-Results

The average JSSF scale was 38.7±12.4 points to 86.8±8.1 points

after TCVO($p < 0.0001$).TAS is from 83.9 ± 6.3°to 59.2 ± 10.3% after DTOO ($p < 0.0001$).MMA was decreased from 45.1± 12.9° to 29.5 ± 9.3°significantly after DTOO ($p < 0.0001$). TTA was decreased from 8.7±8.0° to 3.5±4.0° significantly after DTOO ($p < 0.0001$). TTS was increased from 75.4 ± 8.9° to 90.1 ± 5.2° significantly after DTOO ($p < 0.0001$). TLS was increased from 79.7 ± 7.4° to 86.6 ± 5.9° significantly after DTOO ($p < 0.0001$). AJIA was decreased from 8.6±5.1° to 0.2±0.6 ° significantly after DTOO ($p < 0.0001$)

-Conclusion

DTOO is indicated for all stages of varus ankle OA. The fundamental principle underlying DTOO is stabilization of the ankle joint through the intra-articular correction of an intra-articular deformity. This intra-articular osteotomy improves both bony and soft tissue instability and creates a congruent joint with a load distributed over a larger surface area. DTOO stabilizes varus ankle OA without the need for separate ligament reconstruction.The distal tibial oblique osteotomy (DTOO) is a procedure suited for the ankle osteoarthritis by improving the contact area of the ankle joint and decreasing the load pressure per unit area. This is accomplished with an improvement in ankle stability and a restoration of the hindfoot valgus. Clinical results confirm a reduction in ankle pain and an ability to perform hard manual work or return to sports activities.

Oral Presentation 19 DTO

OS19-1

Open wedge proximal tibial osteotomy with tibial tubercle osteotomy for severe varus deformity of tibia

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-Introduction/Purpose

Active young patients with severe varus knee have a few treatment option. TKA is not recommended for active young patients who want to keep playing sports. We combined open wedge proximal tibial osteotomy (OWPTO) combined with tibial tubercle osteotomy (TTO) to preserve natural joint. The purpose of this report is to introduce the effectiveness of the OWPTO with TTO for severe varus deformity of the proximal tibia.

-Material and Methods

This case series included 5 patients (6 knee) who have severe varus deformity of the proximal tibia. The mean age was 54 years old and the mean preoperative medial proximal tibial angle (MPTA) was 75.3 degree, and all cases have a dilatation distance of 20 mm or more in case of OWHTO. To prevent patella baja and patellofemoral osteoarthritis, we performed OWPTO combined with TTO.

-Results

The average MPTA improved from 75.3 degrees to 92.3 degrees postoperatively and average % MA from -8.9 % to 54.3 %. CD index did not change from 0.71 to 0.71 postoperatively. VAS and KOOS was improved postoperatively. The average follow-up period was 37 (30~47) months and no complications such as non-union, implant failure or infections were observed. All patients returned to their daily activities without significant limitations.

-Conclusion

Open wedge proximal tibial osteotomy combined with tibial tubercle osteotomy was performed for severe varus deformity of the proximal tibia. This method can improve alignment of the leg and clinical score including VAS and KOOS without leg shortening.

OS19-2

Cancellous Autograft Transfer from Screw-hole (CATS) to the opening gap for early bone healing in Interlocking OW-DTO – A novel, previously unrecognized donor-source

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-Introduction/Purpose

Autologous bone grafting offers the best potential for promoting bone healing in osteotomy procedures; however, donor-site morbidity continues to be a concern. In open-wedge high tibial osteotomy and distal tibial tuberosity osteotomy (DTO), the relatively large-diameter screw-holes created during plate fixation penetrate into cancellous bone, representing a previously unrecognized donor source and offering a unique opportunity to obtain autograft without any additional surgical invasion. We developed a novel technique, termed CATS (Cancellous Autograft Transfer from Screw-hole), which enables direct harvesting of cancellous bone from locking plate screw-holes and its transfer into the osteotomy opening gap. This approach causes no donor-site morbidity. The purpose of this study was to evaluate the feasibility, safety, and effectiveness of the CATS technique in promoting early bone healing following interlocking OW-DTO (IL-DTO).

-Material and Methods

This study included eight patients in the early development phase of the CATS system who underwent IL-DTO. Following provisional placement of the plate, cancellous bone was harvested directly from the plate screw-holes using the CATS device. The procedure required no additional surgical invasion beyond standard fixation. The harvested cancellous bone fragments were then transferred into the osteotomy gap. For each case, the volume of harvested bone was estimated. Radiographic and CT evaluations were performed at 2 and 12 weeks postoperatively to assess bone union and gap filling.

-Results

The CATS procedure was feasible in all cases and required an additional ~10 minutes for bone harvesting and transfer. Harvested autologous cancellous bone consisted of 4.5-mm-diameter cylindrical cores with preserved trabecular architecture, obtained piece-by-piece to a cumulative mean length of 8.2 cm (range, 6–13 cm), which was adequate to fill the opening gap of hinge area in most cases. There was a tendency for larger harvest volumes in patients with better bone trabecular quality. CT at 2 weeks confirmed that the graft was appropriately placed within the hinge area. No intraoperative complications or postoperative implant loosening were observed.

-Conclusion

The CATS technique enables harvesting of autologous cancellous bone directly from plate screw-holes without creating a separate donor site. This non-invasive method provides biologically active autograft that accelerates early bone healing in OW-HTO and DTO, and—to our knowledge—represents the first systematic use of plate screw-holes as an autograft donor source.

OS19-3

Evaluation of Bone Union after Open-Wedge Distal Tibial Tubercle Osteotomy Using a Newly Designed Plate

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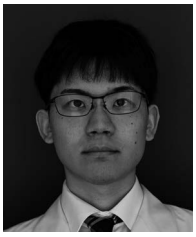
-Introduction/Purpose
Lateral hinge fractures, potentially leading to delayed bone union, remain a common complication after open-wedge distal tibial tubercle osteotomy (OWDTO), occurring in approximately 20–25% of cases. To address this issue, the Tris Brace, a newly designed fixation plate, was developed. Its most distinctive feature is that it allows insertion of a brace screw through the plate, providing additional support to the hinge area without interfering with plate fixation. The purpose of this study was to evaluate the incidence of lateral hinge fractures and bone union after OWDTO using the Tris Brace.
-Material and Methods
A total of 12 knees that underwent OWDTO, including double-level osteotomy (DLO), using the Tris Brace between January 2025 and April 2025 and were followed for at least six months were included. Postoperative rehabilitation included early ambulation without any weight-bearing restrictions. The hip-knee-ankle angle (HKA), lateral distal femoral angle (LDFA), medial proximal tibial angle (MPTA), and posterior tibial slope (PTS) were evaluated preoperatively and at six months postoperatively. The correction angle, opening gap, and intraoperative lateral hinge fractures were evaluated by postoperative computed tomography (CT) at one week after surgery. Lateral hinge fractures identified after this point were defined as postoperative hinge fractures. Bone union at the osteotomy site was evaluated using CT at three and six months postoperatively. The osteotomized gap area of the anteroposterior radiographs was divided into four zones to measure gap filling and bone union. These areas were numbered Zone 1 through Zone 4, starting from the lateral cortex. Bone union was defined as cortical union of the posterior cortex. Additionally, adverse events associated with brace screw insertion were investigated.
-Results
Nine knees underwent OWDTO and three underwent DLO. The mean preoperative radiographic parameters were as follows: HKA, varus 6.1°; LDFA, 87.3°; MPTA, 82.8°; and PTS, 9.8°. Postoperative mean values were HKA, valgus 3.9°; LDFA, 86.3°; MPTA, 92.1°; and PTS, 9.0°. The mean correction angle and opening gap were 9.2° and 10.7 mm, respectively. No intraoperative lateral hinge fractures occurred, whereas postoperative hinge fractures were observed in four knees (33%), all classified as Takeuchi type 1. At three months postoperatively, bone union was confirmed in Zone 1 in 3 knees, Zone 2 in 6 knees, Zone 3 in 0 knees, and Zone 4 in 3 knees. At six months, bone union was observed in Zone 1 in 1 knee, Zone 2 in 0 knees, Zone 3 in 3 knees, and Zone 4 in 8 knees. No adverse events associated with brace screw insertion—including screw loosening, breakage, or inhibition of gap filling—were observed.
-Conclusion
OWDTO using the Tris Brace demonstrated favorable bone union and no complications related to brace screw insertion. Although postoperative lateral hinge fractures were still observed in one-third of cases, they did not affect bone union. Further comparative studies with conventional plate systems are warranted to clarify the advantages of the Tris Brace in bone union.

OS19-4



Takeuchi type1 lateral hinge fractures delay gap filling after Distal Tuberosity arc Osteotomy:A Tomosynthesis study

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【Introduction】
The distal tuberosity arc osteotomy (DTO) is a type of open-wedge proximal tibial osteotomy that prevents patella infera and minimizes the risk of patellofemoral pathology. Lateral hinge fractures (LHFs) are known to increase the risk of delayed gap filling and correction loss after the open-wedge high tibial osteotomy (OWHTO). However, reports on the influence of the LHFs on the DTO are still limited. Tomosynthesis is an imaging technique that uses standard X-ray equipment and digital flat-panel detectors to create tomographic images from very low-dose projections. It is superior to conventional radiography in detecting the fracture and bone formation, especially beneath the metal hardware.
【Purpose】
To investigate the incidence, types, and effects on the gap filling of LHF after the DTO using tomosynthesis
【Materials and Methods】
Twenty-five patients (18 males and 7 females; mean age, 57±8.8 years) who underwent DTO at our institution from January 2021 to January 2024 were enrolled in this study. Tomosynthesis and plain radiographs were obtained at 1 weak and at 3, 6, 9, and 12 months after surgery. The presence of LHF, the Takeuchi classification of LHF, and Schröter's gap filling ratio (GFR) were evaluated. Multiple linear regression analysis was performed using stepwise method to identify independent predictors of GFR at each 3-month interval. The variables included age, body mass index, smoking status, and the presence of LHF. Mean GFR values with or without LHF were compared using Student's t-test. A p-value of less than 0.05 was considered statistically significant
【Results】
The mean correction width of the open wedge was 10.3±2.1mm. LHFs were identified in 7 of 25 knees (28%) on tomosynthesis, and all were classified as Takeuchi type1. Multiple linear regression analysis revealed that the presence of LHF was an independent predictor of GFR at 3 months ($R2=0.255$, $p=0.04$) and 6 months ($R2=0.347$, $p=0.013$). Patients with LHFs showed significantly lower GFR values at 3 months ($p<0.01$) and 6 months ($p<0.01$) compared with those without LHF.
【Conclusion】
The Incidence of LHF after DTO was 28% as assessed by tomosynthesis. Takeuchi type1 LHF was significantly associated with delayed gap filling up to 6 months after DTO surgery. Careful radiological monitoring is required to assess bone healing status after DTO

OS20-1

Long-term Comparison of Opening Wedge High Tibial Osteotomy and Double Level Osteotomy for Large Varus Knee Deformities: A Retrospective Cohort Study of Functional Outcomes, Complications, and Survival Rates

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-Introduction : Opening wedge high tibial osteotomy (OWHTO) and double-level osteotomy (DLO) are commonly performed for correcting large varus knee deformities. This retrospective cohort study compares long-term functional outcomes, complication rates, and survival rates between these two techniques.
-Materials and Methods : Sixty patients who underwent OWHTO (n = 32) or DLO (n = 28) for varus knee correction were evaluated. Outcome measures included the Knee Society Score (KSS) and KSS function score at 1, 5, and 10 years, with percentage improvements analyzed across intervals. Additional measures included hip–knee–ankle (HKA) alignment accuracy, complication rates, and survival rates. Trend analysis was based on 10-year data for OWHTO and 5-year data for DLO.
-Results : DLO demonstrated significantly higher HKA correction accuracy and fewer complications compared to OWHTO, including reduced incidence of joint line obliquity (JLO) (P = 0.001), posterior tibial slope (PTS) change (P = 0.013), and worsening patellofemoral arthritis (PFA) (P = 0.03). KSS improvements were observed in both groups at all intervals, with DLO showing superior KSS Function scores, suggesting higher functional stability. Percentage improvement trends favoured DLO for specific outcomes over the long term.
-Conclusion : DLO provides more accurate HKA alignment with lower complication rates in JLO, PFA, and PTS changes, while both procedures yield comparable overall KSS scores. The enhanced KSS Function outcomes with DLO indicate a potential clinical advantage in maintaining higher functional activity and patient satisfaction over time. These findings support the use of DLO for patients requiring precise correction of significant varus deformities with sustained functional benefits.

OS20-2

Comparison of surgical accuracy in double level osteotomy based on the use of intraoperative alignment rods

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-Introduction/Purpose
The purpose of this study was to investigate the impact of intraoperative alignment rod adjustment on the accuracy of postoperative lower limb alignment in double level osteotomy (DLO). Although alignment rods are often used intraoperatively to fine-tune mechanical alignment, it remains unclear whether such adjustments improve or impair the precision of postoperative outcomes. Therefore, this study aimed to clarify whether intraoperative adjustments contribute positively to achieving the target alignment compared to performing the procedure strictly according to the preoperative plan without additional modifications.
-Material and Methods
A total of 53 patients with medial compartment knee osteoarthritis and varus malalignment who underwent DLO were retrospectively analyzed. The DLO procedure consisted of a lateral closing wedge distal femoral osteotomy combined with a medial open wedge high tibial osteotomy. Patients were divided into two groups based on intraoperative procedures: those in whom correction was modified using an alignment rod during surgery (adjustment group, n = 38) and those in whom correction was performed exactly according to the preoperative plan without intraoperative adjustment (planned group, n = 15). On postoperative single-leg standing full-length radiographs, alignment accuracy was evaluated by comparing the difference between postoperative and planned mechanical axis percentage (%MA). Cases within ±10% of the planned %MA were defined as accurate. Between-group comparisons were conducted using chi-square and t-tests for ΔmLDFA, ΔMPTA, ΔJLCA, and the absolute value of the bony correction error (ΔHKA – ΔJLCA).
-Results
The proportion of patients achieving accurate postoperative %MA was significantly higher in the planned group (73.3%) than in the adjustment group (28.9%) (p = 0.008). While ΔmLDFA, ΔMPTA, and ΔJLCA did not differ significantly between groups, the absolute bony correction error was significantly greater in the adjustment group (2.33° vs. 1.13°, p = 0.022). These findings indicate that intraoperative adjustment using alignment rods may introduce additional variability.
-Conclusion
In DLO, performing surgery according to the preoperative plan without intraoperative alignment rod adjustments leads to superior postoperative alignment accuracy. Excessive intraoperative modifications may inadvertently reduce the precision of the postoperative mechanical alignment.

OS20-3

Radiological evaluation of ankle alignment change after double level osteotomy for varus knee osteoarthritis

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-Introduction/Purpose
The purpose of this study was to radiographically investigate the effect of double level osteotomy (DLO) on ankle alignment in patients undergoing correction for varus knee osteoarthritis.
-Material and Methods
Fifty-eight knees with varus osteoarthritis underwent DLO, which consisted of lateral closing wedge distal femoral osteotomy and medial open wedge high tibial osteotomy. Standing whole-leg radiographs were obtained preoperatively and at two weeks postoperatively. Key parameters measured included knee alignment parameters such as %MA, mechanical lateral distal femoral angle (mLDFA), medial proximal tibial angle (MPTA), and knee joint line obliquity (KJLO) and the ankle alignment parameter (ankle joint line obliquity: AJLO). Changes in each parameter before and after surgery were evaluated using paired t-tests. Correlations between preoperative factors and postoperative AJLO or its change (Delta AJLO) were analyzed using Pearson's correlation coefficient.
-Results
Preoperative knee alignment values were %MA -1.7 ± 10.0%, mLDFA 89.2 ± 1.8°, and MPTA 84.0 ± 2.0°. Postoperatively, these parameters changed significantly ($p < 0.001$) to 70.3 ± 12.4%, 84.0 ± 2.2°, and 92.8 ± 2.3°, respectively. KJLO showed no significant difference between pre- and postoperative measurements (1.0 ± 3.0° vs. 0.5 ± 3.6°, $p = 0.449$). For the ankle, AJLO significantly decreased from 9.1 ± 4.7° preoperatively to -1.5 ± 5.5° postoperatively ($p < 0.001$). Preoperative AJLO correlated positively with postoperative AJLO ($r = 0.31$, $p = 0.016$) and negatively with Delta AJLO ($r = -0.50$, $p < 0.001$). No significant correlations were found between other preoperative knee parameters and postoperative AJLO or Delta AJLO.
-Conclusion
DLO significantly alters the alignment of the adjacent ankle joint. The magnitude of this change was more strongly associated with preoperative AJLO than with preoperative knee alignment.

OS20-4

Clinical Outcomes of Double Level Osteotomy (DLO) in Our Institution

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Introduction
High tibial osteotomy (HTO) is a well-established surgical procedure for the treatment of medial compartment osteoarthritis in patients with varus knee deformity. However, in cases of severe deformity, correction with HTO alone may be inadequate due to excessive changes in the joint line and overcorrection of the tibial plateau. In such situations, double level osteotomy (DLO), which combines distal femoral and proximal tibial osteotomies, has been proposed to achieve more physiological limb alignment and joint line orientation. Several studies have reported favorable short-term outcomes of DLO, highlighting its ability to restore mechanical alignment and improve knee function while maintaining the joint line obliquity within acceptable limits. Nevertheless, DLO is technically demanding and associated with potential complications such as delayed union, infection, or nerve injury. Moreover, the appropriate indications, patient selection criteria, and long-term effectiveness of DLO remain subjects of discussion. Recent reports have emphasized the importance of preoperative planning, particularly regarding mLDFA and JLCA, as undercorrection or excessive intra-articular deformity may lead to suboptimal outcomes. Factors such as age, preoperative alignment, and body mass index (BMI) may also influence postoperative function and satisfaction. The present study aimed to evaluate the mid-term clinical and radiographic outcomes of DLO performed at our institution. Specifically, we investigated (1) the degree of alignment correction, (2) improvement in clinical scores, (3) incidence of postoperative complications, and (4) predictive factors associated with functional outcomes. Furthermore, we sought to clarify the optimal indications and thresholds for achieving favorable results following DLO.
Purpose
Adequate correction of severe varus knee deformity is often difficult to achieve with high tibial osteotomy (HTO) alone. Double level osteotomy (DLO), involving simultaneous distal femoral and proximal tibial osteotomies, is an alternative approach. This study aimed to evaluate the mid-term clinical and radiographic outcomes of DLO performed at our institution and to assess its effectiveness, complications, and appropriate indications.
Materials and Methods
Nineteen knees (9 men, 10 women; mean age, 61.5 years) that underwent DLO for osteoarthritis between 2018 and 2023 were retrospectively analyzed. The mean follow-up period was 38.9 months (range, 24–84 months). Radiographic parameters (%MA, MPTA, mLDFA, JLCA) and Japanese Orthopaedic Association (JOA) scores were evaluated preoperatively, at 1 year, and at final follow-up, and compared with institutional target values (%MA 63–68%, MPTA 93–94°, mLDFA 84–85°). Postoperative complications and factors associated with lower JOA scores were investigated.
Results
The mean %MA improved from –10.8% preoperatively to 63.7% at 1 year and 60.9% at final follow-up. MPTA increased from 82.6° to 93.0°, remaining within target, while mLDFA changed from 92.3° to 87.7°, indicating residual alignment. JLCA decreased from 4.0° to 2.7°. Significant improvements were observed in overall alignment and JOA scores. Complications included superficial infection, delayed bone union, and transient peroneal nerve palsy, with no conversion to total knee arthroplasty. Lower JOA scores were associated with older age, lower %MA, and greater JLCA change.
Conclusion
DLO provided satisfactory alignment correction and clinical improvement. Optimal outcomes were achieved in patients aged ≤66 years with a final %MA ≥63%. Proper patient selection, precise preoperative planning, and achieving target alignment are essential for maximizing postoperative function and satisfaction.

OS20-5

Mid-term outcomes following double level osteotomy in patients with severe varus deformity and advanced knee osteoarthritis.

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Introduction/Purpose: Double-level osteotomy (DLO) is indicated for symptomatic severe varus knee osteoarthritis (OA) to restore physiological joint alignment and bony geometry. Although satisfactory short-term outcomes of this procedure have been reported, there is a paucity of information regarding its mid-term clinical results. Therefore, the purpose of this study was to assess the mid-term outcomes following DLO in patients with severe varus osteoarthritic knees.
Material and Methods: This retrospective study involved a consecutive series of 48 knees in patients with a mean age of 62.0 ± SD years who underwent DLO for advanced knee OA (Kellgren-Lawrence grade 4) with severe varus deformity. All patients completed a minimum follow up of 5 years with a mean duration of 93.3 ± 15.6 months. DLO was indicated in cases with combined varus deformities involving the distal femur and proximal tibia. The surgical procedure consisted of both lateral closing wedge distal femoral osteotomy and medial opening wedge high tibial osteotomy. The postoperative hip-knee-ankle angle (HKA) was targeted at +1° valgus. Clinical outcomes were assessed using the Knee Injury and Osteoarthritis Outcome Score (KOOS), while radiological parameters including lateral distal femoral angle (LDFA), medial proximal tibial angle (MPTA), joint line convergence angle (JLCA) and HKA were measured using whole legs radiographs. All clinical and radiological parameters were evaluated preoperatively, at 2 years postoperatively, and at the final follow-up. In the data analysis, the influence of postoperative geometric parameter values on the clinical outcomes
were statistically assessed. In addition, the incidence and timing of conversion to total knee arthroplasty (TKA) were recorded.
Results: For clinical outcomes, the total KOOS scores demonstrated significant improvement from baseline of 193 ± 74 to 399 ± 74 at 2 years ($p < 0.001$). However, this was followed by a significant decline to 362 ± 92 at final F/U ($p < 0.001$). As for radiological outcome, significant correction of the HKAA was achieved from preoperative 13.8° ± 2.7° varus to 0.9° ± 2.8° varus at 2 years ($p < 0.001$), which indicated under-correction as compared to the intended alignment (1° valgus). While no significant changes were observed on post-operative LDFA and MPTA, a small degree of varus recurrence was noted at the last F/U with mean HKA of varus 1.4° ± 3.7° ($p = 0.013$). While the JLCA decreased from 5.65° ± 2.5° preoperatively to 3.8° ± 2.0° at 2 years, it partially regressed to 4.9° ± 2.1° at the final follow-up. The postoperative KOOS significantly correlated with postoperative HKAA ($r = 0.42$, $p < 0.001$) and JLCA ($r = -0.33$, $p < 0.001$) indicating weak-to-moderate correlations. During the study period, 6 cases (12.5%) underwent subsequent TKA procedures with a mean time of 88.8 months (range, 36-109 months) from DLO.
Conclusions: The present study demonstrated that DLO achieved effective improvement in alignment and function at mid-term follow-up, with a low conversion rate to TKA even in patients with advanced knee OA. Nevertheless, a gradual decline in clinical outcomes and mild recurrence of varus deformity were observed over time.

OS20-6

Clinical outcomes of double-level osteotomy combining Hybrid CWHTO and medial open wedge DFO for varus osteoarthritis with extension deficit

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-Introduction/Purpose
In high tibial osteotomy (HTO), excessive correction resulting in a postoperative medial proximal tibial angle (MPTA) ≥95° is considered undesirable due to the increased joint-line obliquity and shear stress on the tibial plateau. Therefore, a double-level osteotomy (DLO) that includes femoral correction, rather than tibial correction alone, is recommended in such cases. However, in patients with limited knee extension, the optimal femoral osteotomy method combined with Hybrid HTO remains controversial. This study aimed to report short-term outcomes (≥2 years) of patients who underwent Hybrid closed wedge HTO (CWHTO) combined with medial open wedge distal femoral osteotomy (MOWDFO) for medial compartment osteoarthritis with extension deficit.
-Material and Methods
Patients with medial compartment osteoarthritis presenting ≥15° of knee extension limitation and predicted postoperative MPTA ≥95° after isolated tibial correction were included. MOWDFO was performed using a biplanar osteotomy with bone substitute and locking plate fixation. Hybrid CWHTO was performed according to the method described by Takeuchi. Partial weight-bearing was permitted at 4 weeks and full weight-bearing at 6 weeks postoperatively. Radiographic parameters—including mechanical axis (%MA), MPTA, and mechanical lateral distal femoral angle (mLDFA)—were assessed pre- and postoperatively. Bone union time, complications, and patient-reported outcomes (VAS, JKOM, KOOS) were evaluated at 2 years after surgery.
-Results
The mean age at surgery was 61.0 years. The mechanical axis was corrected from –3.3% to 63.4%. Postoperative alignment parameters improved as follows: MPTA from 82.8° to 92.1° and mLDFA from 91.2° to 84.2°. The mean correction angle was 8.2° for the tibia and 6.4° for the femur. Bone union was achieved in all cases, with an average healing time of 2.7 months in the tibia and 3.8 months in the femur. No hinge fractures or other complications were observed. Clinical outcomes significantly improved: the mean VAS score decreased from 65.5 mm to 18.9 mm, JKOM from 55.8 to 19.4, and KOOS from 33.4 to 68.2 (all $p < 0.05$).
-Conclusion
Hybrid CWHTO combined with MOWDFO achieved reliable bone union and favorable short-term clinical results in patients with varus knee osteoarthritis and extension deficit. Although the sample size was limited, this procedure demonstrated satisfactory alignment correction without complications.
These findings suggest that open wedge DFO can serve as a valuable femoral correction technique within double-level osteotomy, particularly for cases in which isolated tibial correction would result in excessive postoperative MPTA.

Oral Presentation 21 Cartilage and anatomy

OS21-1

Superficial MCL Proximal Detachment is an Etiology of Medial Knee Laxity in Osteoarthritis

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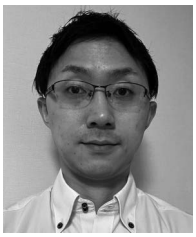
-Purpose : This study aimed to determine the correlation between proximal attachment of superficial medial collateral ligament (sMCL) detachment and medial knee laxity in normal knees and osteoarthritic (OA) knees.
-Material and Methods : A total of 124 patients were enrolled, comprising a Case Group (N=62) with OA (mean age 71.74±6.87 years; mean FTA=182.75±5.04) and a Control Group (N=62) with normal knees (mean age 32.33± 6.86 years; mean FTA=175.33±2.07). Medial knee laxity was assessed using radiographic JLCA difference and correlated with sMCL status (attached vs. detached) in both case and control groups. Inter-observer reliability for sMCL status (Cohen's Kappa, κ) and medial knee laxity (Intraclass Correlation Coefficient, ICC) was rigorously assessed. Statistical comparisons utilized Chi-squared tests and Fisher's Exact Test, with $P < 0.05$ considered significant.
-Results : The overall prevalence of medial knee laxity was highly significantly greater in the OA group (59.68%) compared to the normal controls (4.84%) ($P < 0.001$). Within the OA population, sMCL detachment was strongly associated with laxity. Patients with a detached sMCL (N=55) exhibited a laxity rate of 65.45% versus 14.29% in those with an attached sMCL (N=7). This difference was statistically significant, yielding an Odds Ratio of 11.37 ($P = 0.0143$).
-Conclusion : Superficial medial collateral ligament detachment represents a critical, independent factor contributing to the development and severity of medial knee laxity in osteoarthritis.

OS21-2



Abnormal Branching of the Anterior Tibial Artery

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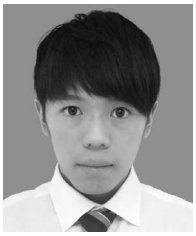
Introduction/Purpose
Popliteal artery injury is a serious complication of high tibial osteotomy. Normally, the popliteal artery branches into the anterior and posterior tibial arteries near the lower border of the popliteus muscle. However, in some cases, the anterior tibial artery branches at a more proximal level, which may increase the risk of vascular injury. The purpose of this study was to investigate the frequency of abnormal branching of the anterior tibial artery.
Material and Methods
A total of 501 knees (112 right, 81 left, and 154 bilateral cases) from 347 patients (127 males and 220 females) who underwent knee MRI at our institution were analyzed. Using MRI, we evaluated the branching level of the anterior tibial artery from the popliteal artery and the anatomical relationship between the anterior tibial artery and the popliteus muscle.
Results
A proximal branching pattern of the anterior tibial artery was observed in 9 of 501 knees (1.8%). Among these, 3 cases (0.6%) showed the artery running anterior to the popliteus muscle.
Conclusion
We observed cases in which the anterior tibial artery branched proximally and coursed anterior to the popliteus muscle. In such cases, the artery runs immediately posterior to the tibial cortex, markedly increasing the risk of arterial injury during high tibial osteotomy. Therefore, preoperative assessment of the popliteal artery course using MRI is important to ensure surgical safety.

OS21-3



Dynamic Positional Changes of Knee Soft Tissues During Flexion and Extension: A Retrospective Open MRI study

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Introduction and Purpose
Various surgical approaches are utilized for periarticular fractures and reconstructive surgery around the knee, such as high tibial osteotomy (HTO). Although iatrogenic injury to the popliteal artery is rare, occurring in 0.01–0.51% of HTO, it remaines a devastating complication associated with substantial surgical risk. However, the dynamic movement of posterior soft tissues, particularly the popliteal artery (PA), relative to the bone during knee flexion and extension is not often considered in surgical planning. The purpose of this study was to clarify the dynamic positional changes of periarticular PA and surrounding muscles relative to the femur and tibia during knee flexion and extension using open magnetic resonance imaging (MRI).
Methods
This was a single-center, retrospective, MRI-based anatomical study. Twenty-three patients who underwent MRI examination at our institution between February 1 and July 31, 2017, were included. MRI examination was performed using an open MRI scanner (Hitachi OASIS, 1.2T). Images were acquired in two standardized positions: 10° and 90° of knee flexion. Measurements were performed at 0, 1, 2, 3, and 4 cm proximal to the intersection of Blumensaat's line and the posterior femoral cortex on the sagittal plane to determine the distance between the posterior femoral cortex and PA (F-PA), and the distances between the posterior femoral cortex to the posterior edges of the vastus lateralis (F-VL), and vastus medialis (F-VM). Measurements were also performed at 0, 1, 2, 3, and 4 cm distal to the tibial joint surface to determine the distances between the posterior tibial cortex and the popliteal artery and vein (T–PA) on the sagittal plane. Statistical analysis was performed using the Mann-Whitney U test, with $p < 0.05$ considered statistically significant.
Results
The 23 patients included 10 males and 13 females, with a mean age of 44.2 years. Comparing Position E (10° flexion) and Position F (90° flexion), the F-PA distance was significantly longer in Position F at the 0 and 1 cm proximal levels (16.7 mm vs 30.2 mm and 13.2 mm vs 20.7 mm, respectively; both $p < 0.05$). No significant differences were observed at the 2, 3, and 4 cm levels. The T-PA distance was also significantly longer in Position F at the 1 and 2 cm distal levels (7.8 mm vs 10.8 mm and 9.8 mm vs 13.2 mm, respectively; both $p < 0.05$). Conversely, in Position F, the F-VM distance was significantly shorter at the 2, 3, and 4 cm proximal levels (all $p < 0.05$). Furthermore, the F-VL distance was significantly shorter in Position F at all measured levels (all $p < 0.05$).
Conclusion
Our study demonstrates significant position-dependent mobility of the PA, VL, and VM relative to the femur and tibia. The results suggest that knee extension facilitates safer and more effective surgical exposure of the lateral and medial femoral cortex during femoral osteotomy along the VL and, at proximal levels, along the VM. Conversely, knee flexion may help reduce the risk of iatrogenic PA injury during exposure of the posterior femoral and tibial cortex for each osteotomy.

OS21-4

Intra-Articular Mesenchymal Stem Cell Injection for Knee Osteoarthritis: A Narrative Review of Clinical and MRI-Based Morphologic Outcomes

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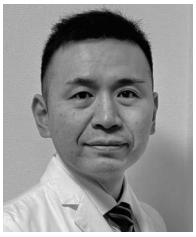
-Introduction/Purpose: Osteoarthritis (OA) is a progressive degenerative joint disease characterized by chronic pain and functional impairment. Although conservative and surgical treatments can alleviate symptoms, they do not fully restore damaged articular cartilage. Intra-articular mesenchymal stem cell (MSC) therapy has emerged as a minimally invasive option that may modulate the intra-articular environment and promote cartilage repair. However, the degree to which MSCs can induce true morphological cartilage restoration remains uncertain. Therefore, this study aimed to systematically evaluate clinical outcomes and MRI-based morphological changes following intra-articular MSC injections for knee OA.
-Material and Methods: A literature search of MEDLINE was conducted up to January 30, 2025, using the keywords ("mesenchymal stem cell" OR "MSC") AND "injection" AND ("cartilage" OR "osteoarthritis"). Of the 544 identified articles, 53 clinical studies investigating intra-articular MSC injections for cartilage lesions or knee OA were selected. Among these, 20 studies that included MRI-based cartilage morphological assessment were analyzed in detail. Basic science and animal studies were excluded.
-Results: Of the 20 included studies, 16 were randomized controlled trials, and the remaining studies were prospective single-arm or comparative cohort designs. Most patient cohorts included individuals with moderate to advanced OA (Kellgren–Lawrence grade II–IV). MSCs were most commonly derived from bone marrow or adipose tissue and were administered either as single or multiple injections. Dosing regimens varied considerably across studies. Across all study types, clinical outcomes generally improved, with reductions in pain and improvements in functional scores such as WOMAC and KOOS. Symptom relief was typically observed within 3–6 months and was sustained for 12–24 months or longer in several cohorts. Treatment was well tolerated overall, with no major safety concerns reported.
MRI-based morphological assessments demonstrated variable findings. Approximately half of the studies reported no significant structural improvement, suggesting that MSC therapy provided clinical benefit primarily through symptomatic and biological modulation rather than measurable cartilage regeneration. In contrast, the other half reported partial morphological improvements, including increased cartilage thickness or slowed degenerative progression. Among studies utilizing advanced MRI techniques, T2 mapping was more sensitive in detecting subtle improvements in cartilage quality in one study, while three studies using similar MRI assessment methods reported no significant differences compared with control groups.
-Conclusion: Intra-articular MSC injection appears to be a safe and clinically effective therapy for knee OA, consistently improving pain and function. However, MRI-based evidence indicates that while MSC therapy may partially restore or stabilize cartilage structure, complete regeneration of native hyaline cartilage remains uncommon, and approximately half of the studies showed no meaningful morphological improvement. Further standardized and well-controlled clinical trials are needed to determine optimal indications, dosing strategies, and expected structural outcomes.

OS21-5



Correlation Between Plate Selection and Risk of Lateral Neurovascular Bundle Injury in Medial Open Wedge High Tibial Osteotomy

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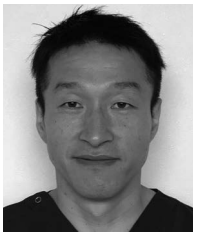
-Introduction/Purpose
Medial open wedge high tibial osteotomy (OWHTO) is an effective surgical treatment for medial compartment knee osteoarthritis with varus deformity. However, injury to the lateral neurovascular bundle (NVB), including the deep peroneal nerve and anterior tibial vessels, during distal screw fixation remains a significant complication. Several OWHTO plates designed based on Japanese bone morphology are currently available. This study investigated the relationship between plate positioning and the risk of NVB injury during distal screw insertion, comparing two different plate systems.
-Material and Methods
We retrospectively analyzed 101 knees in 94 patients who underwent OWHTO between January 2022 and February 2025, with available postoperative CT evaluation. The cohort included 83 knees treated with TriS plates (TR group) and 18 knees with ASPIC plates (AS group). Plate positioning was assessed using postoperative CT imaging, measuring the angle (A) between the proximal plate tangent and posterior tibial condyle tangent, and the distance (D) between the distal plate edge and tibial crest. The spatial relationship between each distal screw trajectory and the NVB was categorized as anterior (a), center (c), or posterior (p). Multiple logistic regression analysis was conducted with screw position (c=0 or a/p=1) as the dependent variable, and A, D, and plate type as independent variables, performed separately for each distal screw (#1-#4). In addition, propensity score matching was performed using A and D as variables, and the proportions of a/c/p positions were compared using Fisher's exact test between matched groups.
-Results
Multiple logistic regression analysis of the entire cohort (101 knees) revealed significant differences in NVB injury risk patterns between plate types. For the most proximal distal screw (#1), the AS group had significantly lower odds of directing toward the NVB compared to the TR group (OR: 0.017, 95%CI: 0.002-0.11, $p<0.001$), indicating that TriS plates posed higher risk at this position. Conversely, for the most distal screw (#4), the TR group showed significantly elevated risk compared to the AS group (OR: 6.59, 95%CI: 1.72-25.1, $p=0.006$). The angle and distance parameters also significantly influenced screw positioning patterns for screws #1 and #4.
To further examine these differences while controlling for plate positioning, propensity score matching was performed using A and D as variables, yielding 11 knees in each group with comparable positioning parameters. In this matched cohort, Fisher's exact test confirmed significant differences in the distribution of screw trajectories (a/c/p) for all distal screws between groups ($p<0.05$ for all). Specifically, the AS group demonstrated predominantly center positioning for screw #1 (81.8% center vs. 0% in TR group, $p<0.001$), while the TR group showed predominantly center positioning for screw #4 (90.9% center vs. 36.4% in AS group, $p=0.024$). These findings validated the plate-specific risk patterns identified in the regression analysis.
-Conclusion
This study demonstrates that the risk of NVB injury during distal screw insertion in OWHTO varies significantly depending on plate selection. The different design philosophies between plate systems result in distinct screw trajectory patterns, with each system presenting higher risks at different screw positions. Surgeons should recognize that plate selection influences the location and magnitude of NVB injury risk and must implement appropriate preventive strategies accordingly.

OS21-6



Magnetic resonance angiography-assisted visualization of blood flow to the bone tunnel wall and the tendon graft into the bone tunnel after posterior cruciate ligament reconstruction

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Purpose: Postoperative outcomes after posterior cruciate ligament (PCL) reconstruction have not improved sufficiently. In this study, we visualized and quantified blood flow into the bone tunnel wall and tendon grafts using magnetic resonance angiography (MRA) in 2 patients who underwent PCL reconstruction.
Materials and Methods: MRA images were processed using imaging software (OsiriX®) and the mean signal intensities in the femoral and tibial bone tunnel walls and the tendon graft in the bone tunnel were measured manually. Signal intensity was standardized by dividing by the signal value at the point approximately 2 cm anterior to the tibial rough part. Case 1: The patient was a 19-year-old female who injured her PCL while playing basketball. Single-bundle PCL reconstruction was performed using a multiple strands semitendinosus tendon. Case 2: The patient was a 29-year-old male who injured his PCL after a fall from a high place. In procedures similar to those for case 1.
Results: The bone tunnel walls in the femoral and tibial sides of cases 1 and 2 were compared; consequently, high intensity signals were detected in the tendon graft in the bone tunnel. In comparison of the signal intensity between the femoral and tibial sides, blood flow in the bone tunnel wall and the tendon graft on the tibial side was greater than that on the femoral side.
Conclusion: Blood flow to the bone tunnel and tendon grafts was more abundant on the tibial side 8 months and 1 year after PCL reconstruction compared with the femoral side.
Key words: Posterior cruciate ligament reconstruction, Magnetic resonance angiography, Multiple strands semitendinosus tendon, Revascularization

OS22-1

Game-Changing Technology for Meniscus Repair: Injectable ChitHCl-DDA tissue adhesive with high adhesive strength and biocompatibility for torn meniscus repair and regeneration

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-Introduction/Purpose
Meniscus repair surgery often faces challenges related to suture pull-through due to the sharp edges of traditional sutures. To address this issue, we explored a novel tissue adhesive developed from chitosan hydrochloride and oxidative periodate-oxidized dextran (ChitHCl-DDA), combined with a chitosan-based hydrogel and oxidative dextran, as an alternative for meniscus repair.
-Material and Methods
Various formulations of ChitHCl-DDA were synthesized and characterized by gelation time, FTIR, rheological behavior, swelling ratio, degradation, and lap shear strength. In vitro assays assessed cytocompatibility, cell migration, and glycosaminoglycan (GAG) synthesis using SW1353 chondrocytes. Ex vivo (porcine meniscus) and in vivo (rabbit meniscus) models were used to evaluate adhesion, regeneration, and meniscal extrusion via histology and MRI.
-Results
Optimized formulations showed gelation within 2–5 minutes, stable elastic moduli, controlled swelling, and degradation rates suitable for meniscal healing. The best-performing adhesive achieved lap shear strength >700 kPa before swelling and >150 kPa after. Cell viability exceeded 90% in most groups, with enhanced migration and GAG synthesis. Histological and ToF-SIMS analyses confirmed collagen regeneration at the adhesive-tissue interface. In vivo, reduced meniscus extrusion and tissue integration were observed at 4 weeks postoperatively. ChitHCl-DDA adhesives demonstrated strong tissue adherence and biocompatibility, supporting cell migration and extracellular matrix production. Mechanical and biological performance met the demands of meniscal repair, and some formulations showed efficacy even without sutures.
-Conclusion
This study validates the potential of ChitHCl-DDA as a biodegradable and effective tissue adhesive for meniscus repair, offering a promising alternative to traditional sutures and advancing strategies for regenerative orthopedic surgery.

OS22-2

Optimal Target Alignment to Restore Medial Contact Pressure in Medial Meniscus Posterior Root Tears

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-Introduction/Purpose: A medial meniscus posterior root tear (MMPRT) is closely linked with increased contact pressure in the medial compartment and the progression of medial compartment osteoarthritis. High tibial osteotomy (HTO) is used to correct varus alignment, subsequently alleviating stress on the medial meniscus and reducing pressure in the medial compartment. Consequently, HTO procedures have increasingly been performed for the treatment of MMPRT. However, the optimal target alignment in HTO for MMPRT remains unclear. This study aimed to investigate the alignment necessary to restore contact pressure in the medial compartment to normal levels with and without MMPRT repair.
-Material and Methods: A total of 10 fresh-frozen cadaveric legs from human donors (mean age: 61.3 years; range, 33–75 years; 6 male, 4 female) were used in this study. This study was approved by the Institutional Research Ethics Board. A joint motion simulator was employed to simulate HTO by varying the % weight-bearing line (WBL), ranging from 30 to 70%. Tibiofemoral mean contact pressure (MCP) was measured in both medial and lateral compartments using Tekscan pressure sensors placed under the meniscus, with a 700 N load applied along each simulated weight-bearing line for 30 s. The MMPRT models were created via a femoral posterior approach, incising 3 mm from the root attachment, and MMPRT repair models were anatomically repaired using suture anchors. Measurements were acquired for intact, MMPRT, and repair conditions at various alignments (30, 40, 50, 55, 60, 65, and 70%WBL) in both medial and lateral compartments. Neutral alignment was defined as 50%WBL. MCP values were compared among conditions using repeated-measures ANOVA with Bonferroni adjustment. Paired t-tests compared MCP at control (intact 50% WBL) with other alignments. Statistical significance was set at $p < 0.05$.
-Results: MCP gradually increased with varus alignment under all conditions. MCP was significantly higher in the MMPRT condition than in the intact and repair conditions at 30–55% WBL (all $p < 0.05$). In the repair condition, MCP was similar to or slightly higher than that in the intact condition across all alignments; however, these differences were not statistically significant (all $p > 0.05$). In the MMPRT condition, compared with intact 50% WBL, no significant differences were observed at 60% ($p = 0.281$) or 65% WBL ($p = 0.638$), but significant differences were found at 55% ($p = 0.008$) and 70% WBL ($p = 0.013$). Similarly, in the repair condition, compared with intact 50% WBL, no significant differences were observed at 50% ($p = 0.129$) or 55% WBL ($p = 0.394$), but significant differences were found at 60%, 65%, and 70% WBL (all $p < 0.05$). Thus, intact 50% WBL biomechanically corresponded to 60–65% in MMPRT and 50–55% after repair, defining distinct alignment thresholds. In the lateral compartment, MCP increased progressively with valgus alignment, but no significant differences were observed among conditions (all $p > 0.05$).
-Conclusion
MCP at neutral alignment in the intact knee was similar to values at 60–65% WBL for unrepaired MMPRT and 50–55% WBL for repair conditions, indicating optimal biomechanical alignment targets for HTO in patients with MMPRT. These findings provide biomechanical evidence to guide optimal knee alignment during HTO for MMPRT, potentially improving patient outcomes.

OS22-3

Intra-articular migration of the tibial bone plug during anterior cruciate ligament reconstruction with bone-patellar tendon-bone autograft: a case series

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- Purpose : Bone-patellar tendon-bone (BPTB) autografts are a preferred choice for anterior cruciate ligament (ACL) reconstruction due to their potential for reliable bone-to-bone healing. However, technical errors can lead to significant complications.
- Methods : This report presents a series of three cases where the tibial bone plug of a BPTB autograft migrated into the intra articular space.
- Result : Postoperative analysis identified that proximal displacement of femoral bone plug, divergence of the interference screw during femoral screw fixation was the primary cause. This led to proximal migration of the graft, increase of tension, and subsequent displacement of the tibial bone plug.
- Conclusion : These cases underscore the critical importance
of meticulous surgical technique, particularly in ensuring accurate screw placement to prevent graft migration.

OS22-4

A successful application of circumferential fiber augmentation as a proactive prevention of MMPRT in a patient with a positive spreading roots sign

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-Introduction: A medial meniscus posterior root tear (MMPRT) is a catastrophic failure of the meniscus that irreversibly disrupts hoop tension, precipitating rapid articular cartilage degeneration. Patients frequently report prodromal symptoms, specifically dull pain in the popliteal region, prior to the actual root rupture. Recent literature has identified a critical MRI finding termed the “spreading roots sign” (SRS), characterized by a specific pattern of bone marrow edema radiating from the insertion of the medial meniscus posterior root. This imaging sign is believed to represent a physiological response to supraphysiologic tensile loads accumulating on the meniscal hoop, effectively acting as a harbinger of imminent root failure. Current standard of care, such as transtibial pull-out repair, is reactive, treating the pathology only after complete mechanical failure. Theoretical early intervention during the SRS phase could halt progression to a frank MMPRT. We hypothesized that structural reinforcement of the meniscal hoop during this prodromal window would dissipate the pathological stress causing the SRS. Meniscal circumferential fiber augmentation (CFA) is an emerging biomechanical procedure designed to reconstitute functional hoop tension by supplementing the endogenous circumferential collagen network with a durable suture tape. This case report details the successful application of CFA as a proactive therapeutic strategy in a patient presenting with a positive SRS.
-Case Report: A 57-year-old female presented with a 3-month history of persistent, insidious left knee pain. Initial MRI by a referring physician raised suspicion of medial meniscal pathology. Upon presentation to our institution, physical examination demonstrated evident left knee effusion and tenderness localized to the medial popliteal fossa. Meniscal provocation testing (McMurray test) was negative. Baseline range of motion (ROM) was 0° extension to 150° flexion. Weight-bearing radiographs revealed mild bilateral medial joint space narrowing. High-resolution T2-weighted fat-suppressed coronal MRI confirmed the continuity of the medial meniscus posterior root; nevertheless, it demonstrated a distinct SRS, characterized by bone marrow edema spreading from the root attachment adjacent to the intercondylar eminence, suggestive of critical stress concentration. Given these findings indicative of an impending tear, we indicated CFA to structurally reinforce the compromised meniscal hoop. The surgical technique utilized a high-strength suture tape to intimately augment the native circumferential fibers, as previously described. The tape was firmly anchored to the tibia to ensure rigid fixation and immediate restoration of hoop tension. The postoperative rehabilitation protocol involved initial immobilization with a knee brace for 2 weeks, followed by progressive ROM exercises. Weight-bearing was restricted to partial load at 3 weeks, advancing to full weight-bearing by 4 weeks postoperatively. To protect the augmented repair, deep knee flexion was restricted to 130° for the first 6 months. At the 6-month follow-up interval, the patient reported complete alleviation of her left knee pain. Functional ROM was satisfactory at 3° extension to 140° flexion. Follow-up weight-bearing radiographs confirmed preservation of the medial joint space width. Notably, serial MRI scans obtained at 3 and 6 months postoperatively demonstrated complete resolution of the SRS and a favorable morphological appearance of the augmented meniscus, confirming that MMPRT had not occurred.
-Conclusion: The successful prevention of MMPRT in a patient with SRS strongly implies that CFA effectively dissipated the supraphysiologic tensile stresses at the meniscal root attachment. This case underscores the potential of CFA as a viable, proactive therapeutic intervention for patients exhibiting the SRS, offering a strategy to potentially avert progression to catastrophic MMPRTs.

OS22-5

Meniscal centralization anchors inserted at the articular margin are less likely to fail than those inserted at the articular surface

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[Introduction/Purpose] Although good clinical outcomes have been reported for meniscal centralization, loosening of the anchor sutures is occasionally observed during second-look arthroscopy. Therefore, we hypothesized that the suture loosening may occur depending on the anchor position.

[Material and Methods] For cases in which two-anchor centralization was performed, the anchor positions were indicated by a clockface position on postoperative CT and classified into insertion on the plateau (P group) and insertion on the edge (E group), and the presence of loosening of the sutures was examined by second-look arthroscopy. Meniscal centralization was performed using two anchors, anterior and posterior. The clock face position was based on previous reports, drawing the Akagi line and a line perpendicular to it and representing the maximum diameter of the articular surface, with the anterior at 12 o'clock, medial at 3 o'clock, posterior at 6 o'clock, and lateral at 9 o'clock.

[Results] A total of 47 patients (mean age 56.4 years) were included. The anterior anchor was positioned at an average of 2:08, with 30 patients in P group and 17 in E group, and loosening of the anchor suture was observed in 27 (90%) and 8 (47%) cases, respectively. The posterior anchor was positioned at an average of 3:06, with 34 patients in P group and 13 in E group, and loosening was observed in 33 (97%) and 6 (46%) cases, respectively. In both cases, loosening was significantly more common in P group ($p<0.05$).

[Conclusion] Meniscal repair anchors are less likely to fail when inserted on the edge rather than the articular surface.

Oral Presentation 23 Evaluation

OS23-1

Association Between Preoperative Pain Catastrophizing and Postoperative KOOS Scores Following Around-the-Knee Osteotomy

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-Introduction/Purpose

Preoperative psychological factors are known to influence postoperative outcomes in patients undergoing around-the-knee osteotomy (AKO). However, the longitudinal impact of preoperative pain catastrophizing on postoperative functional recovery remains unclear. This study aimed to investigate the effect of preoperative pain catastrophizing on postoperative patient-reported outcome measures (PROMs) following AKO over time.

-Material and Methods

A total of 96 knees (25 males, 71 females; mean age, 63 ± 9 years) that underwent AKO were included. The procedures comprised open wedge high tibial osteotomy (OWHTO; n = 76), medial closed wedge distal femoral osteotomy (MCWDFO; n = 7), double-level osteotomy (DLO; n = 11), and inverted V-shaped high tibial osteotomy (iVHTO; n = 2). The Kellgren–Lawrence grades were as follows: Grade 1 (n = 20), Grade 2 (n = 42), Grade 3 (n = 31), and Grade 4 (n = 3).

Preoperative pain catastrophizing was assessed using the Pain Catastrophizing Scale (PCS). Patients were categorized into two groups: high PCS (≥30 points, n = 28) and low PCS (<30 points, n = 68). Clinical outcomes were evaluated using the Knee injury and Osteoarthritis Outcome Score (KOOS) preoperatively and at 3, 6, and 12 months postoperatively.

-Results

The KOOS Pain and Activities of Daily Living (ADL) subscales were significantly lower in the high PCS group than in the low PCS group throughout the 12-month postoperative period ($p < 0.05$).

-Conclusion

High preoperative pain catastrophizing was associated with poorer postoperative PROMs following AKO over time. These findings emphasize the importance of psychological assessment and early intervention to optimize functional recovery after AKO.

OS23-2

Association Between CPAK (Coronal Plane Alignment of the Knee) Classification and Clinical Outcomes In High Tibial Osteotomy

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-Introduction

The Coronal Plane Alignment of the Knee (CPAK) classification has recently been introduced to describe lower limb alignment patterns before and after total knee arthroplasty (TKA). However, few studies have applied this concept to high tibial osteotomy (HTO). The purpose of this study was to evaluate postoperative alignment using the CPAK classification in patients who underwent HTO and to investigate the relationship between CPAK phenotypes and clinical outcomes, including patient-reported outcomes.

-Material and Methods

A total of 43 knees that underwent HTO between March 2022 and August 2024 were included in this retrospective study. One-year postoperative standing radiographs were analyzed to classify coronal alignment according to the CPAK system. Postoperative mechanical axis parameters, including the hip-knee-ankle angle (HKA), percentage mechanical axis (%MA), and arithmetic HKA (aHKA), were also measured. Clinical outcomes were assessed using the Knee injury and Osteoarthritis Outcome Score (KOOS) at one year postoperatively as a patient-reported outcome measure (PROM).

-Results

Preoperatively, 81.4% of the cases were classified as CPAK type 1, indicating varus alignment with medial joint line inclination. Postoperatively, most cases were categorized as valgus phenotypes: type 6 (horizontal joint line) was the most common (58.1%), followed by type 9 (lateral inclination, 20.9%) and type 3 (medial inclination, 14%). Altogether, 93% of knees showed valgus alignment after HTO. Postoperative aHKA correlated significantly with postoperative HKA and %MA, indicating internal consistency of the alignment parameters.

There were no significant differences among CPAK types 3, 6, and 9 in any of the KOOS subscales, despite differences in joint line obliquity. This suggests that clinical outcomes at one year were not influenced by the postoperative joint line inclination pattern.

-Conclusion

The CPAK classification is a useful framework for evaluating coronal alignment after HTO. Although most cases achieved valgus correction, the postoperative CPAK phenotype, particularly joint line obliquity, did not significantly affect one-year clinical or patient-reported outcomes. Long-term follow-up studies are warranted to clarify the impact of postoperative coronal alignment patterns on clinical durability and knee function.

OS23-3

Evaluation of Prognostic Factors in Open Wedge High Tibial Osteotomy Using Preoperative MRI Findings

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-Introduction/Purpose
Medial open-wedge high tibial osteotomy (OWHTO) is an effective surgical procedure for medial compartment osteoarthritis (OA) of the knee. However, the influence of preoperative MRI findings on postoperative clinical outcomes remains unclear. We hypothesized that patients with worse preoperative MRI findings would have poorer clinical outcomes at a minimum of two years after OWHTO. This study aimed to quantify preoperative MRI findings using the Whole-Organ Magnetic Resonance Imaging Score (WORMS) and to investigate their association with postoperative clinical outcomes.
-Material and Methods
Patients who underwent OWHTO for medial knee OA between 2015 and 2019, performed by two senior orthopedic surgeons at our institution, were retrospectively reviewed. Inclusion criteria were a minimum of two years of postoperative follow-up and the availability of preoperative MRI. Exclusion criteria included previous ipsilateral knee surgery, ligament injury requiring surgical treatment, history of revision surgery such as total knee arthroplasty (TKA), or combined procedures such as Autologous Chondrocyte Implantation (ACI) performed with HTO. All patients followed a standardized postoperative rehabilitation protocol: partial weight-bearing with crutches was allowed two weeks after surgery, and full weight-bearing was permitted at four weeks. Radiological parameters—including the hip–knee–ankle angle (HKA), percentage of mechanical axis (%MA), femorotibial angle (FTA), and medial proximal tibial angle (MPTA)—were evaluated preoperatively and at two years postoperatively. Preoperative MRIs were evaluated by an orthopedic surgeon, and WORMS subscores were calculated for each lesion type (cartilage: 0–36, meniscus: 0–24, bone marrow edema-like lesions [BML]: 0–18, subchondral cysts: 0–18, joint effusion: 0–3). Clinical outcomes were assessed using the Lysholm score and the Knee injury and Osteoarthritis Outcome Score (KOOS) both preoperatively and at the two-year follow-up. Correlations between WORMS subscores and postoperative KOOS were analyzed using Spearman's rank correlation. Multiple linear regression analysis was conducted with the KOOS Symptoms subscale as the dependent variable, and age, BMI, WORMS-based BML, and postoperative HKA as independent variables.
-Results
A total of 54 knees (46 patients) met the inclusion criteria. Ten knees were excluded (five lost to follow-up, one underwent TKA, one developed rheumatoid arthritis after surgery, two underwent combined ACI with HTO, and one had prior ACL reconstruction), leaving 44 knees (36 patients) for analysis. The mean age at surgery was 60.1 ± 9.3 years, and the mean BMI was 27.7 ± 5.1 kg/m². Seventeen knees (15 patients) were male. Both the Lysholm and KOOS scores significantly improved from preoperatively to two years postoperatively ($p < 0.001$ for all). Radiographic alignment parameters also significantly improved. WORMS-based BMLs were negatively correlated with all KOOS subscales. In particular, trochlear BML showed significant negative correlations with KOOS Symptoms ($r = –0.39$, $p = 0.016$), Pain ($r = –0.32$, $p = 0.034$), ADL ($r = –0.48$, $p < 0.001$), and Sport/Rec ($r = –0.34$, $p = 0.024$). In the multivariate analysis, trochlear BML was independently and negatively associated with postoperative KOOS Symptoms ($\beta = –7.2$, 95% CI: –13.5 to –0.9, $p = 0.027$), while age, BMI, and postoperative HKA were not significant.
-Conclusion
Preoperative trochlear BMLs were significantly associated with decreased KOOS Symptoms scores at two years after OWHTO. These findings suggest that the presence of trochlear BMLs may negatively affect postoperative clinical outcomes. Preoperative MRI assessment using WORMS, particularly the evaluation of trochlear BMLs, may be useful for predicting postoperative results and for optimizing patient selection and surgical planning.

OS23-4

Evaluation of the patient satisfaction with implant removal after open wedge high tibial osteotomy.

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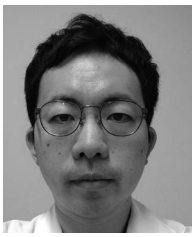
-Introduction/Purpose
Implant removal in orthopedic surgery is often performed in Japan, but in Europe and the United States, it tends to be performed when complaints due to implants are observed. There is also a risk of complications due to removal implants, and there is no consensus on the effectiveness of removal implants. It has been reported that removal implants after ankle surgery or fracture fixation of extremities resulted in high rate of patient satisfaction. Open wedge high tibial osteotomy (OWHTO) is a common procedure for knee osteoarthritis, but complications from implants are relatively common. To our knowledge, there are no reports evaluation of the patient satisfaction with removal implants after OWHTO. This study is a prospective study that examined the effectiveness of removal implants by evaluation of the patient satisfaction with removal implants after OWHTO.
-Material and Methods
From August 2021 to August 2023, we prospectively studied 35 patients who underwent removal implants after OWHTO at our hospital and completed 3 months of postoperative follow-up. We performed evaluations before removal implants and 3 months after surgery. The primary endpoint was patient satisfaction (postoperatively answered on a 5-point scale: very satisfied, satisfied, neither satisfied nor dissatisfied, dissatisfied, and very dissatisfied with the removal implants). Secondary endpoints included the following: age, gender, BMI, joint range of motion, length of hospital stay, KL classification, %MA, FTA, MPTA, Knee injury and Osteoarthritis Outcome Score(KOOS), 36-Item Short-Form Health Survey(SF-36), VAS, NRS, Short-Form McGill Pain Questionnaire 2(SF-MPQ2), and our own questionnaire (5-point scale for the following 10 items: 1. Wound tenderness, 2. Numbness of the wound, 3. Warmth and coldness of the wound, 4. Feeling strange of the wound, 5. Color of the wound, 6. Unevenness of the wound, 7. Stiffness of the wound, 8. Scarring of the wound, 9. Discomfort of the wound, 10. Overall knee condition). In addition, we examined factors related to patient satisfaction.
-Results
Thirty-four of the 35 patients were more than satisfied with the removal implants. The following items showed significant improvement after surgery: knee flexion angle, KOOS (Total, Pain, Function, daily living, Quality of life), VAS, NRS, SF-36 (Physical functioning, Mental health, Physical component summary), own questionnaire (tenderness, numbness, feeling strange, unevenness, tightness, discomfort and overall knee condition). Patient satisfaction was negatively correlated with postoperative pain score (VAS: $r=-0.47$, $p=0.004$).
-Conclusion
The patient satisfaction with implant removal after OWHTO was very high. We considered that the reduction of postoperative pain by the removal implants resulted in high patient satisfaction, since postoperative pain and patient satisfaction were negatively correlated. We consider that the removal implants after OWHTO is highly effective.

OS23-5



Hardware removal after open-wedge high tibial osteotomy improves clinical outcomes and hardware-related complications

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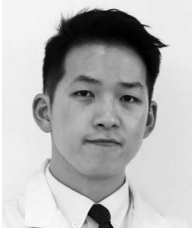
-Introduction/Purpose
Open-wedge high tibial osteotomy (OWHTO) is the standard and safe procedure for medial compartment osteoarthritis. Although hardware removal (HWR) is performed after OWHTO, the effects of HWR on OWHTO have been rarely reported. We hypothesised that HWR would improve range of motion (ROM) and implant-related complications. Thus, this study aimed to investigate the effects of HWR on postoperative ROM, the Japan Orthopaedic Association (JOA) score/visual analogue scale (VAS) score and hardware-related complications after OWHTO.
-Material and Methods
Patients who underwent OWHTO between January 2016 and June 2018 and HWR were retrospectively reviewed. To perform OWHTO, locking plates and artificial bone were used to achieve optimal stabilisation of biplanar osteotomy. After confirming bone union via radiographic imaging, HWR was performed through the previous skin incision following a second-look arthroscopy. For clinical evaluation, the JOA score, VAS score, and ROM were assessed before and 1 year after HWR using the Wilcoxon rank test. Logistic regression analysis was performed to identify the predictors of post-HWR improvement.
-Results
Of 98 knees examined (91 patients), 80 (73 patients; 39 men and 34 women) were included. At the time of OWHTO, mean age was 64.0 ± 9.7 years and body mass index, 25.5 ± 3.1 kg/m2; Kellgren-Lawrence (KL) grade 1 was seen in 20 cases, KL-2 in 46, and KL-3 in 14. Mean periods between OWHTO and HWR were 13.4 ± 2.0 months, and 11.9 ± 1.2 months between HWR and evaluation. The JOA score and flexion angle significantly improved after HWR (The JOA score: $p = 0.026$ flexion angle: $p < 0.001$); however, the VAS score and extension angle did not (VAS score: $p = 0.162$, extension angle: $p = 0.934$). Hardware irritation was observed in four cases (5%), which improved after HWR. Logistic regression analysis revealed that lower preoperative KL grade and flexion angle were predictors of improvement after HWR [KL grade: $p = 0.008$; odds ratio 3.244, 95% confidence interval (CI) 1.350-7.794; flexion angle: $p < 0.001$; odds ratio 1.150, 95% CI 1.062-1.245].
-Conclusion
HWR improves flexion angle, clinical outcomes and hardware-related complications after OWHTO. Preoperative KL grade and flexion angle are predictors of improvement after HWR in patients who have undergone OWHTO.

OS24-1



A Multicenter Randomized Controlled Trial for a Novel Digital Therapeutics for Treatment of Patellofemoral Pain, a Dilemma in Orthopedics.

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-Introduction/Purpose: Patellofemoral pain (PFP) is a common disease that causes functional impairments and psychological distress, mainly in younger patients. Although many patients consult orthopedic surgeons, surgical treatment is typically ineffective and may aggravate symptoms. This study aimed to evaluate the efficacy of a mobile app–based digital therapeutic (DTx) that integrates exercise therapy and cognitive-behavioral therapy (CBT) for PFP.
-Material and Methods: In this prospective randomized controlled trial, conducted across 10 orthopedic outpatient clinics, 216 adults with chronic PFP lasting at least 3 months and minimal or no radiographic knee osteoarthritis were randomly assigned to either the DTx group or control group. The DTx group received an 8-week mobile app program (MORA Cure PFP) delivering personalized exercise and CBT content, followed by a 4-week observation period. The control group received a single face-to-face exercise education session, printed educational materials, and a daily exercise log. Outcomes were assessed at baseline and at weeks 4, 8, and 12, including usual and worst pain (visual analogue scale, 0-100), functional status (Anterior Knee Pain Scale), quality of life, pain catastrophizing, and depressive symptoms. All randomized participants were included in the intention-to-treat population, except one with no outcome data.
-Results: There were no significant differences in all the baseline variables evaluated between the DTx and control group. From week 4, the DTx group showed significantly greater improvements in pain and function. Usual pain decreased by 12.5 points and worst pain by 10.7 points at week 8, with further reductions by week 12 (both $p<0.001$). AKPS scores improved by 2.7 points at week 4 ($p=0.032$) and reached an 8.7-point difference at week 12 ($p<0.001$). Quality of life and psychological outcomes also improved significantly in the DTx group from week 8 ($p<0.05$). Exercise adherence was higher in the DTx group (80.9% vs. 71.3%), and CBT session adherence averaged 74.6%, indicating strong engagement.
-Conclusion: This novel mobile app-based DTx combining exercise and CBT resulted in significantly greater improvements in pain, function, and psychological outcomes compared to usual care. High adherence supports the feasibility and acceptability of this DTx for PFP with potential for broad clinical application for a variety of patients with PFP-type symptoms.

OS24-2

The Effect of Sensor-based Rehabilitation (SR) on Chronic Knee Pain (CKP) outcomes - A Systematic Review and Meta-Analysis (SRMA)

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Introduction
This study aims to evaluate the effect of sensor-based rehabilitation (SR) on chronic knee pain (CKP) outcomes.
Methods
PubMed, Embase, CINAHL, SCOPUS, Cochrane Library, grey literature and bibliographic references were searched from inception to April 2023. Only randomized controlled trials (RCTs) and cohort studies evaluating the outcomes of SR on CKP were included. Inclusion and exclusion criteria were based on type of study, research subjects, intervention, outcome, language and availability of data. Out of 937 studies screened, a total of ten studies with 4347 patients studies met selection criteria. Comparison of outcomes following intervention was conducted across studies. Meta-analysis of KOOS subscales was also conducted. Literature retrieval and data extraction were conducted by three independent reviewers. Two reviewers performed quantitative data extraction independently before compilation and cross-referencing on Covidence with a third researcher assisting in the cross-referencing process independently to minimise judgment errors.
Results
Sensors utilized included wearable sensors, plantar-controlled sensors, embedded sensors and optical sensors. There was a high degree of variability in the conduct of the intervention programmes, and time point of assessment. There was an improvement in the KOOS aggregate scores from baseline to post-intervention with better improvements seen in studies incorporating avatar-based biofeedback. However, meta-analysis of the KOOS subscales did not show clinically significant differences between control and intervention groups.
Conclusion
There is insufficient evidence to support the routine use of SR in patients with CKP. However, there is some evidence to suggest that incorporation of SR with avatar-based biofeedback in a multi-faceted treatment approach may yield better outcomes than the use of sensors as merely activity trackers.

OS24-3

Correlation Between Preoperative and Postoperative Quadriceps Strength After Around Knee Osteotomy Combined with Osteochondral Autograft Transplantation

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-Introduction/Purpose
Around knee osteotomy (AKO) is an effective surgical procedure for patients with knee osteoarthritis (KOA), particularly for those who are relatively active and wish to maintain a higher level of daily functioning. Quadriceps strength (QS) is closely associated with activities of daily living (ADL), including walking and stair climbing, and its weakness has been shown to correlate significantly with functional limitations and disability. Therefore, postoperative recovery of QS is a key determinant of successful functional improvement following AKO. Previous studies show mixed findings on postoperative QS. Some studies found a sharp drop in QS at three months, recovery to preoperative levels by six months, and improvement by nine months, while others saw ongoing weakness one year after surgery. These differences may reflect small sample sizes, varied rehab protocols, and the effect of contralateral limb weakness from bilateral disease or less activity after surgery. While the link between pre- and postoperative QS is clear after ACL reconstruction (ACLR) and total knee arthroplasty (TKA), it is not well defined following high tibial osteotomy (HTO). At our institution, osteochondral autograft transplantation (OAT) is done together for cartilage repair of the femoral groove and the medial compartment. This requires arthrotomy and partial quadriceps exposure, which may lower strength after surgery regardless of preoperative strength. However, the effect of preoperative muscle strength on results is still unclear. This study examined the association between pre- and postoperative QS after HTO with OAT for cartilage damage of the femoral groove and medial compartment. Understanding this could clarify whether preoperative strength helps even with intra-articular surgery.
-Material and Methods
We included patients who had HTO with OAT between January 2022 and September 2023. Criteria were available preoperative QS and at least 12 months of follow-up. At our institution, rehab after HTO with OAT is delayed to protect the graft. Partial weight-bearing began at 6 weeks, full at 8 weeks; standard HTO cases begin at 1 and 3 weeks. Resistive quadriceps exercises started at 12 weeks. Isometric knee extension strength was measured by a dynamometer (BIODEX System 4). Peak torque was normalized to body weight (Nm/kg). We used Spearman's rank correlation for the relationship between pre- and postoperative (1-year) QS, with $p < 0.05$ as significant.
-Results
A total of 87 patients were analyzed. Preoperative and postoperative (1-year) QS showed a strong positive correlation (Spearman's $\rho = 0.84$, $p < 0.001$), indicating that patients with greater preoperative strength tended to maintain higher postoperative strength, even with arthrotomy and delayed rehabilitation.
-Conclusion
Although cartilage repair procedures such as OAT require arthrotomy and may temporarily compromise muscle function, preoperative quadriceps strength remained strongly associated with postoperative strength 1 year after HTO combined with OAT. These findings suggest that even in patients undergoing joint-preserving surgery with intra-articular intervention, preoperative muscle conditioning plays a crucial role in postoperative recovery. From a clinical standpoint, evaluating and optimizing quadriceps strength before surgery may improve functional outcomes following AKO.

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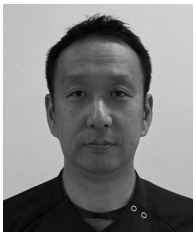

Quadriceps Strength Recovery After Around Knee Osteotomy: Comparing 3-Week vs. 8-Week Full Weight-Bearing Protocols

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-Introduction/Purpose: Knee extensor strength in knee osteoarthritis (KOA) is an important outcome related to both the progression of KOA and pain. Quadriceps strength has been shown to be more closely associated with radiographic findings and cartilage volume in KOA than with symptoms or physical function. Furthermore, there is an association between quadriceps strength and knee pain. Around knee osteotomy (AKO) is a surgical procedure performed for KOA. Surgery and limitations on weight-bearing often lead to neuromuscular inhibition and muscle weakness. Post AKO protocols may also include a period of non and/or partial weight-bearing. Previous studies suggested that while differences in knee extensor strength exist up to 3 months post-operation between groups initiating weight-bearing as early as possible versus those starting full weight-bearing at 3 weeks, there is no significant difference at 12 months. Specifically, knee extensor strength after AKO was significantly lower until 3 months, showed no difference from pre-op at 6 months, and was higher than pre-op at 9 months. Various AKO techniques have been developed, and the post-operative weight-bearing protocol varies by technique and institution. At our institution, the standard weight-bearing protocol after AKO involves initiating partial weight-bearing a week post-op and initiating full weight-bearing 3 weeks post-op. However, if cartilage damage is observed in the lateral femoral condyle and osteochondral transplantation (OAT) is performed, weight-bearing initiation is delayed until 6 weeks post-op, with full weight-bearing commencing at 8 weeks. While it's suggested that initiating weight-bearing as early as possible may facilitate earlier muscle strength recovery, the impact of a comparatively long period of weight-bearing restriction on muscle strength remains unclear. Therefore, the purpose of this study was to determine whether there is a difference in muscle strength recovery based on the timing of full weight-bearing initiation.
-Material and Methods: Inclusion criterion were patients who underwent AKO at our institution. Exclusion criteria was a history of AKO on the contralateral knee, concomitant patellofemoral cartilage damage requiring OAT, and having undergone a double-level osteotomy. Included AKO patients were divided into two groups based on their differing weight-bearing protocols: those with cartilage lesion in lateral condyle who received OAT and those who did not. The weight-bearing protocols for the cohort that received OAT on the lateral condyle and the cohort that did not were, respectively: partial weight-bearing initiation at day 8 and day 43, and full weight-bearing initiation at day 22 and day 57. Knee extensor muscle strength was measured using the isokinetic dynamometer (BIODEX System4) to assess normalized isometric and isokinetic knee extension strength at 60°/s pre-operatively, and at 6, 12, 24, and 36 months post-operatively. The t-test was used for statistical analysis, with a significance level set at 5% ($p < 0.05$).
-Results: A total of 102 knees in 102 patients were included and divided into two cohorts: 15 knees that underwent OAT due to cartilage damage in the lateral condyle (OAT cohort) and 87 knees that did not (non-OAT cohort). The mean age, height, weight, and BMI were 64.1 ± 9.3 years and 63.2 ± 8.1 years; 161 ± 8 cm and 161 ± 10 cm; 66.6 ± 10 kg and 67.3 ± 10 kg; and 25.4 ± 2.5 and 25.8 ± 2.7, respectively. No significant differences were observed between the two cohorts in extensor muscle strength at pre-operation, 6 months, 12 months, 24 months, and 36 months post-operation (extensor strength (0°/s) p-values: 0.941, 0.911, 0.983, 0.588, 0.158; extensor strength (60°/s) p-values: 0.582, 0.731, 0.860, 0.647, 0.266).
-Conclusion: No difference in knee extensor muscle strength was observed at any time point between the two cohorts with different post-operative partial and full weight-bearing initiation times.

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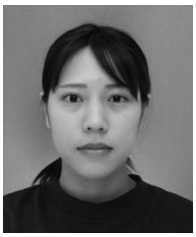

Difficulties of Scrub Nurses in High Tibial Osteotomy

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-Introduction/Purpose: Scrub nurses play a vital role in maintaining the surgical field and providing appropriate instruments to surgeons at the right time. In my daily work, I often assist in both total knee arthroplasty (TKA) and high tibial osteotomy (HTO). Although both are knee surgeries, I have noticed that HTO is more challenging for scrub nurses than TKA. This study aimed to clarify why scrub nurses experience more difficulties in HTO by analyzing their intraoperative movements and identifying the unique factors of this procedure.
-Material and Methods: We recorded and analyzed the movements of 11 operating room nurses during HTO. Video recordings were used to observe their positions, movements, and timing of instrument handover. We focused on how scrub nurses maintained visibility of the operative field, anticipated the surgeon's needs, and adjusted the instrument table according to changes in the surgeon's position. We also observed their actions when the fluoroscope was used, as this required reorganization of the surgical field.
-Results: Video analysis revealed several distinctive behaviors of scrub nurses during HTO. To maintain the same surgical view as the surgeon, nurses often moved their instrument table together with themselves when the surgeon changed positions. When the surgeon's body direction blocked the field of view, nurses approached with the next instrument already prepared to ensure smooth handover. During fluoroscopic imaging, the surgeon frequently stood at the patient's foot to check alignment, requiring nurses to reposition the instrument table for accessibility and safety. These findings indicate that scrub nurses in HTO must constantly anticipate the surgeon's next action, maintain visibility, and reposition themselves while ensuring sterility. Such dynamic adjustments differ from the relatively stable environment seen in TKA.
-Conclusion: In general, scrub nurses stand on the surgeon's dominant-hand side to pass instruments efficiently. In some surgeries with narrow and deep fields, such as pelvic operations, mirrors can assist visibility; however, this is not possible in HTO due to frequent movement of the surgical team. From this analysis, four unique characteristics of HTO were identified: (1) the surgeon sometimes stands at the patient's foot side, (2) the incision is on the lateral side of the knee, (3) the surgeon moves more frequently during the procedure, and (4) fluoroscopy is required. These factors make HTO a particularly complex and mobile operation for scrub nurses. To respond effectively, they must think independently, predict the surgeon's movements, and continuously identify the best position within limited space. By proactively repositioning themselves and the instrument table, scrub nurses create a safer and more efficient surgical environment and contribute greatly to the smooth progression of the operation.