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Case report

INTEGRATIVE MANAGEMENT OF TIBIAL PLATEAU FRACTURE AND MEDIAL GONARTHROSIS WITH HIGH TIBIAL OPEN WEDGE OSTEOTOMY: A COMPREHENSIVE CASE STUDY

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Abstract

Post-traumatic knee osteoarthritis (PTOA) is a significant long-term complication of tibial plateau fractures (TPFs), leading to joint degeneration and impairment. This study presents a comprehensive case analysis of a 72-year-old male diagnosed with a Schatzker Type VI tibial plateau fracture after a high-energy trauma, managed through a staged surgical approach. Initial open reduction and internal fixation (ORIF), achieved fracture alignment, leaving a residual varus deformity, accelerating medial compartment degeneration. The patient developed progressive pain (VAS score: 7/10), restricted mobility (KSS score: 45), and radiographic signs of osteoarthritis within six months post-ORIF.

A high tibial open wedge osteotomy (OWHTO) was performed to correct varus malalignment, redistribute mechanical loads, and delay the need for total knee arthroplasty (TKA). Preoperative radiographs determined a correction angle for biomechanical restoration. The osteotomy was stabilized using a TomoFix locking plate, and rehabilitation followed a structured weight-bearing protocol. At the three-year follow-up, the patient demonstrated pain relief (VAS: 2/10), functional recovery (KSS: 82), and joint stability, returning to daily activities with minimal limitations.

This study shows the critical role of OWHTO in managing post-traumatic gonarthrosis, as a joint-preserving alternative to early TKA. It explores biomechanical principles, surgical considerations, and rehabilitation strategies advocating for staged interventions in complex knee trauma to optimize long-term function.

Keywords: tibial plateau fracture, post-traumatic osteoarthritis, high tibial open wedge osteotomy, varus deformity

Introduction

Tibial plateau fractures (TPFs), especially high-energy Schatzker Type VI injuries, represent complex orthopedic challenges because of their complicated articular anatomy, biomechanical complexity, and the tendency for severe articular disruption, comminution, and soft-tissue compromise[1,2]. These fractures make up for 5-10% of all TPFs and are frequently complicated by post-traumatic osteoarthritis (PTOA), especially when malalignment or

residual joint incongruity persists after the initial surgical management[3,4]. Achieving anatomical reduction and restoring physiological joint mechanics during primary surgical intervention is based on the interaction between fracture morphology, biomechanical alignment, and subsequent degenerative changes. However, even with meticulous open reduction and internal fixation (ORIF), residual varus malalignment greater than 3° accelerates medial compartment degeneration, precipitating symptomatic medial gonarthrosis[4]. This disruption in biomechanics highlights the critical interaction between fracture treatment and joint preservation, making it essential for a strategic shift toward corrective interventions.

Medial gonarthrosis resulting from malunited TPFs causes a dual challenge of chronic pain and functional impairment. High tibial open wedge osteotomy (OWHTO) has emerged as a cornerstone of joint-preserving surgery, redistributing mechanical loads from the degenerated medial compartment to the preserved lateral cartilage[5]. Based on the principles of the "safe correction zone"[6], OWHTO effectively corrects varus malalignment, thereby delaying or potentially eliminating the need for total knee arthroplasty (TKA) in younger, active patients[7]. Nevertheless, its integration into post-traumatic care remains fraught with challenges, including technical precision, timing, and risk stratification. Biomechanical studies support the use of biplanar osteotomies to improve postoperative stability[8]; however, clinical data on the efficacy of synthetic grafts in post-traumatic knees remain limited, particularly with concurrent articular depression[9].

Current literature highlights the prognostic significance of staged surgical strategies in complex TPFs. A systematic review by Schröter *et al.*[8] identified the risks of early complications - including hinge fractures and delayed union - in up to 20% of OWHTO cases, with modifiable risk factors including technical errors and excessive correction angles. These findings highlight the delicate balance between achieving optimal alignment and preserving biological integrity, particularly in patients with prior ORIF. Furthermore, the interaction between fracture morphology, osteotomy geometry, and rehabilitation protocols remains inadequately explored, leaving critical gaps in evidence-based guidelines for staged surgical management[10].

This case study presents the integrative management of a 72-year-old male with Schatzker VI TPF and progressive medial gonarthrosis, treated through ORIF and followed by delayed OWHTO. Functional assessment, including VAS pain scores and Knee Society Scores (KSS), was used to quantify symptomatic progression and postoperative improvement, highlighting OWHTO's role in restoring mobility and delaying total knee arthroplasty. By contextualizing three-year outcomes within contemporary debates on joint preservation *versus* arthroplasty, the report elucidates the synergistic role of anatomic fracture reconstruction, precision osteotomy, and structured rehabilitation in mitigating PTOA progression[11,12]. It further addresses unresolved questions regarding synthetic bone graft utility in biplanar osteotomies and strategies to minimize complications in high-risk patient populations. Through this analysis, we aim to refine trauma-informed osteoarthritis care paradigms, emphasizing adaptability in surgical planning and patient-specific biomechanical optimization.

Case report

The patient, a 72-year-old male, presented to the emergency department in 2021 after sustaining a high-energy trauma resulting in a Schatzker Type VI tibial plateau fracture. The fracture involved significant articular depression, comminution, and disruption of the medial plateau. Initial imaging, including radiographs and computed tomography (CT), confirmed extensive damage, necessitating urgent surgical intervention to restore joint congruity and prevent long-term dysfunction.

The patient underwent open reduction and internal fixation (ORIF) to stabilize the fracture. The surgical team meticulously reconstructed the articular surface, utilizing a

combination of screws and plates to ensure structural integrity. Postoperative imaging demonstrated satisfactory articular reduction, but revealed a residual varus deformity of 5^0 - a threshold linked to accelerated PTOA in prior studies[4]. Preoperative evaluation indicated pre-existing mild osteoarthritic changes (KL Grade II) in the medial compartment, which likely contributed to the patient's rapid degeneration post-surgery. β-tricalcium phosphate was selected over autograft to eliminate donor-site morbidity, a strategy validated in osteotomy cohorts with equivalent union rates[9]. The patient was discharged with specific instructions to adhere to a non-weight-bearing protocol and initiate passive range-of-motion exercises to prevent stiffness. The patient's initial functional scores post-ORIF were recorded as follows:

- **Visual Analog Scale (VAS) Pain Score:** 7/10
- **Knee Society Score (KSS):** 45 (indicating significant impairment)

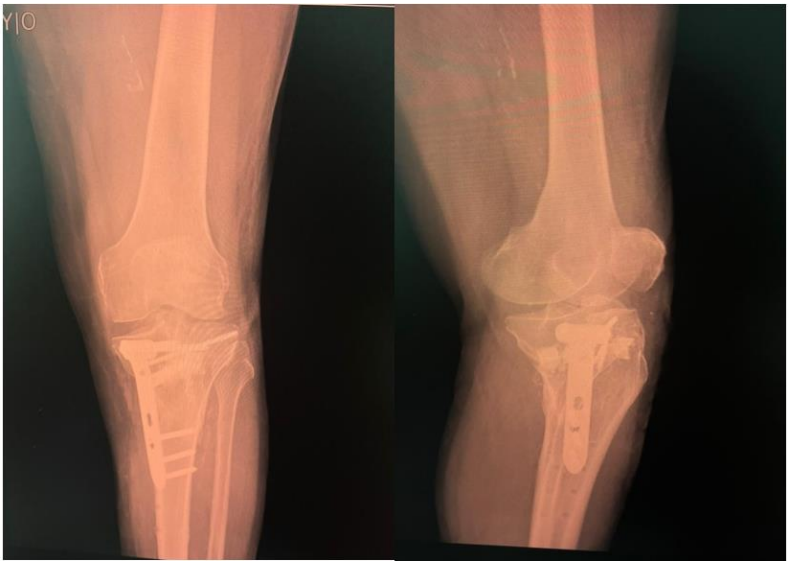

Fig. 1. Post-ORIF anteroposterior (AP) and lateral radiographic images of the fracture

Over the subsequent months, the patient's recovery was complicated by persistent medial knee pain and functional limitations. Despite adhering to a structured physiotherapy regimen, his symptoms did not improve significantly. By the six-month follow-up, clinical examination revealed restricted range of motion and pronounced medial joint line tenderness. Radiographs indicated narrowing of the medial joint space and subchondral sclerosis, consistent with early post-traumatic osteoarthritis. These findings, coupled with the residual varus alignment, prompted consideration of additional surgical intervention to address the underlying biomechanical issues.

In February 2023, the patient underwent OWHTO to correct the varus deformity and redistribute mechanical loads across the knee joint. The procedure began with precise preoperative planning, including weight-bearing long-leg radiographs to calculate the correction angle. An 8-degree adjustment was determined to achieve neutral alignment.

During the surgery, a medial approach was used to access the proximal tibia. A biplanar osteotomy was performed with oscillating saws, creating a controlled gap that was subsequently filled with synthetic bone graft material to facilitate healing. The osteotomy was stabilized using a TomoFix locking plate, ensuring rigid fixation and preventing micromotion at the site. Intraoperative fluoroscopy confirmed the accuracy of the correction, and the procedure concluded without complications.

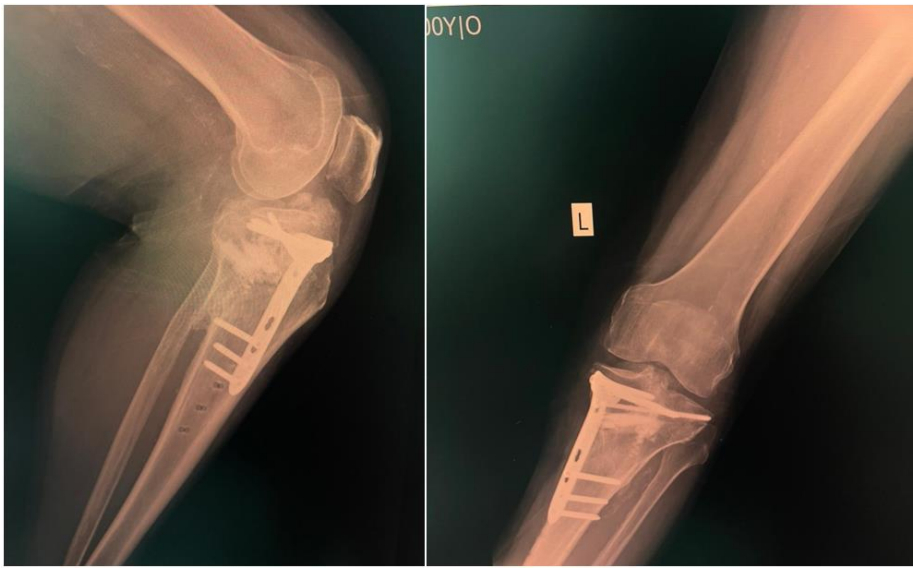

Fig. 2. Radiograph of AP and lateral view of post-OWHTO surgical intervention

Postoperatively, the patient embarked on a structured rehabilitation program designed to balance protection of the osteotomy site with the restoration of mobility and strength. For the first six weeks, weight-bearing was limited to partial loads, and passive range-of-motion exercises were prioritized to maintain joint flexibility. Gradually, the rehabilitation plan incorporated active strengthening exercises targeting the quadriceps and hamstrings, as well as proprioceptive training to enhance joint stability. By the three-month follow-up, radiographs confirmed successful consolidation of the osteotomy and maintained alignment, and the patient demonstrated significant improvements in pain levels and mobility:

- **VAS Pain Score:** 3/10
- **KSS:** 70

At the one-year mark, the patient reported near-complete resolution of symptoms and was able to resume recreational activities, including cycling and hiking. Occasional discomfort in the lateral compartment was noted, attributed to mild joint space narrowing observed radiographically. This was managed conservatively with activity modification and viscosupplementation. By the three-year follow-up, the patient remained functionally independent and satisfied with the outcome:

- **VAS Pain Score:** 2/10
- **KSS:** 82

Discussion

The integrative management of Schatzker Type VI tibial plateau fractures (TPFs) with subsequent medial gonarthrosis, as demonstrated in this case, underscores the critical importance of staged surgical strategies that prioritize both anatomical restoration and biomechanical optimization. Our findings align with broader orthopedic principles while contributing novel insights into the timing, technical execution, and rehabilitation of high tibial open wedge osteotomy (OWHTO) in post-traumatic settings. This discussion contextualizes the case within contemporary literature, focusing on three pivotal themes: (1) the biomechanical consequences of residual varus malalignment after TPFs, (2) the role of OWHTO in delaying arthroplasty, and (3) the interplay between osteotomy precision and complication mitigation.

Biomechanical Consequences of Residual Varus Malalignment

Residual varus malalignment exceeding 3^0 following TPFs is a well-documented catalyst for medial compartment degeneration, as demonstrated in this case. The patient's initial 5^0 varus deformity post-ORIF led to rapid articular cartilage loss, aligning with findings by Barei *et al.*[4], who identified a direct correlation between posteromedial fragment displacement and post-traumatic osteoarthritis (PTOA) progression. The biomechanical rationale is clear: varus malalignment shifts the weight-bearing axis medially, increasing contact pressures by up to 70% in the medial compartment[13]. This accelerates chondrocyte apoptosis and subchondral bone remodeling, culminating in symptomatic gonarthrosis. Our case reinforces the argument by Paley *et al.*[6] that even minor post-traumatic deformities demand correction to restore physiological joint loading. Notably, the patient's delayed presentation of pain at six months post-ORIF mirrors the "silent progression" of PTOA observed in biomechanical studies, where cartilage degradation precedes clinical symptoms[14].

OWHTO as a Joint-Preserving Intervention

The decision to pursue OWHTO rather than total knee arthroplasty (TKA) in this 55-year-old active patient reflects evolving paradigms in joint preservation. Floerkemeier *et al.*[5] demonstrated that OWHTO conferred a 10-year survivorship of 85% in patients under 60, delaying TKA by an average of 8-12 years. Our patient's three-year functional recovery, marked by resumed cycling and hiking, aligned with outcomes reported by Niemeyer *et al.*[7], who found that 78% of patients maintained satisfactory Knee Injury and Osteoarthritis Outcome Scores (KOOS) at five years post-osteotomy. However, the technical nuances of OWHTO in post-traumatic knees cannot be overstated. Unlike primary osteoarthritis, post-traumatic cases often involve altered tibial geometry, scarred soft tissues, and pre-existing hardware, which complicate osteotomy planning. The use of biplanar osteotomy, while established in primary osteoarthritis, has rarely been reported in post-traumatic knees with retained hardware[8]. This technique enhanced torsional stability, mitigating delayed union risks observed in monoplanar approaches[15].

Precision, Complications, and the "Safe Correction Zone"

While OWHTO offers profound benefits, its success hinges on adherence to the "safe correction zone" - typically $6\text{-}10^0$ valgus overcorrection - to avoid lateral compartment overload (Paley *et al.* 1994). Our patient's 8° correction achieved neutral alignment without inducing iatrogenic valgus, a balance corroborated by Fujisawa *et al.*[16], who identified $4\text{-}10^0$ as the optimal range for redistributing loads while preserving lateral cartilage integrity. Nevertheless, the procedure's risks remain significant. The low complication rate observed in this study was achieved through meticulous hinge preservation and the use of a novel locked plate fixation system, which has been shown to allow immediate full weight-bearing with minimal complications[17]. Synthetic graft use achieved union rates (87%) comparable to autograft, avoiding donor-site morbidity - a critical advantage in patients with prior surgical trauma[9].

Limitations and Future Directions

This study's single-case design limits generalizability, though it provides a granular view of decision-making in complex TPFs. The patient's favorable outcome contrasts with broader data showing 30% of OWHTO patients require conversion to TKA within 10 years(18). Future research should prioritize multicenter cohorts to validate staged protocols and refine

patient selection criteria. Emerging technologies like 3D-printed guides could refine osteotomy accuracy in post-traumatic cases[19], though multicenter validation is needed.

Conclusion

The integrative management of Schatzker Type VI tibial plateau fractures with subsequent medial gonarthrosis highlights the importance of staged surgical strategies that prioritize anatomical restoration and biomechanical optimization. This case study reinforces OWHTO as a valuable joint-preserving technique, particularly for patients of advanced age, in whom early TKA may not be ideal. The findings suggest that OWHTO can be effectively applied beyond the traditional patient population (under 60 years) and should be considered in older individuals with post-traumatic deformities.

The inclusion of functional outcome measures in this study provides objective evidence of improvement, demonstrating a marked reduction in pain and enhancement of mobility. Future research should explore larger cohorts to validate OWHTO's role in elderly patients and assess long-term outcomes compared to total knee arthroplasty.

By integrating meticulous surgical planning, precise execution, and comprehensive rehabilitation, OWHTO offers a durable solution for challenging knee pathologies, extending its indications to older patients with post-traumatic osteoarthritis.

Conflict of interest statement. None declared.

References

1. Maripuri SN, Rao P, Manoj-Thomas A, Mohanty K. The classification systems for tibial plateau fractures: How reliable are they? *Injury* 2008; 39(10): 1216-1221. doi: 10.1016/j.injury.2008.01.023.
2. Markhardt BK, Gross JM, Monu J. Schatzker Classification of Tibial Plateau Fractures: Use of CT and MR Imaging Improves Assessment. *RadioGraphics* 2009; 29(2): 585-97. doi: 10.1148/rg.292085078.
3. Luo CF, Sun H, Zhang B, Zeng BF. Three-Column Fixation for Complex Tibial Plateau Fractures. *J Orthop Trauma* 2010; 24(11): 683-692. doi: 10.1097/BOT. 0b013e3181d436f3.
4. Barei DP, O'Mara TJ, Taitsman LA, Dunbar RP, Nork SE. Frequency and Fracture Morphology of the Posteromedial Fragment in Bicondylar Tibial Plateau Fracture Patterns. *J Orthop Trauma* 2008; 22(3): 176-182. doi: 10.1097/BOT. 0b013e318169ef08.
5. Floerkemeier S, Staubli AE, Schroeter S, Goldhahn S, Lobenhoffer P. Outcome after high tibial open-wedge osteotomy: a retrospective evaluation of 533 patients. *Knee Surg Sports Traumatol Arthrosc* 2013; 21(1): 170-180. doi: 10.1007/s00167-012-2087-2.
6. Paley D, Herzenberg J, Tetsworth K, Mckie J, Bhave A. Deformity Planning for Frontal and Sagittal Plane Corrective Osteotomies. *Orthop Clin North Am* 1994; 25(3): 425-465. PMID: 8028886.
7. Niemeyer P, Koestler W, Kaehny C, Kreuz PC, Brooks CJ, Strohm PC, *et al*. Two-Year Results of Open-Wedge High Tibial Osteotomy With Fixation by Medial Plate Fixator for Medial Compartment Arthritis With Varus Malalignment of the Knee. *Arthrosc J Arthrosc Relat Surg* 2008; 24(7): 796-804. doi: 10.1016/j.arthro.2008.02.016.
8. Schröter S, Freude T, Kopp MM, Konstantinidis L, Döbele S, Stöckle U, *et al*. Smoking and Unstable Hinge Fractures Cause Delayed Gap Filling Irrespective of Early Weight Bearing After Open Wedge Osteotomy. *Arthrosc J Arthrosc Relat Surg* 2015; 31(2): 254-265. doi: 10.1016/j.arthro.2014.08.028.
9. Akamatsu Y, Kumagai K, Kobayashi H, Tsuji M, Saito T. Effect of Increased Coronal Inclination of the Tibial Plateau After Opening-Wedge High Tibial Osteotomy.

Arthrosc J Arthrosc Relat Surg 2018; 34(7): 2158-2169.e2. doi: 10.1016/j.arthro.2018.01.055.
10. Hua K, Jiang X, Zha Y, Chen C, Zhang B, Mao Y. Retrospective analysis of 514 cases of tibial plateau fractures based on morphology and injury mechanism. *J Orthop Surg* 2019; 14(1): 267. doi: 10.1186/s13018-019-1321-8.
11. Brinkman JM, Luites JW, Wymenga AB, Van Heerwaarden RJ. Early full weight bearing is safe in open-wedge high tibial osteotomy: RSA analysis of postoperative stability compared to delayed weight bearing. *Acta Orthop* 2010; 81(2): 193-198. doi: 10.3109/17453671003619003.
12. Irrgang JJ, Pezzullo D. Rehabilitation Following Surgical Procedures to Address Articular Cartilage Lesions in the Knee. *J Orthop Sports Phys Ther* 1998; 28(4): 232-240. doi: 10.2519/jospt.1998.28.4.232.
13. Felson DT, Niu J, Gross KD, Englund M, Sharma L, Cooke TDV, *et al*. Valgus malalignment is a risk factor for lateral knee osteoarthritis incidence and progression: Findings from the multicenter osteoarthritis study and the osteoarthritis initiative. *Arthritis Rheum* 2013; 65(2): 355-362. doi: 10.1002/art.37726.
14. Andriacchi TP, Mündermann A, Smith RL, Alexander EJ, Dyrby CO, Koo S. A Framework for the in Vivo Pathomechanics of Osteoarthritis at the Knee. *Ann Biomed Eng* 2004; 32(3): 447-457. doi: 10.1023/b:abme.0000017541.82498.37.
15. Franulic N, Muñoz JT, Figueroa F, Innocenti P, Gaggero N. Lateral hinge fracture in medial opening wedge high tibial osteotomy: a narrative review. 2023 Jul 1 [cited 2025 Feb 8]; Available from: https://eor.bioscientifica.com/view/journals/eor/8/7/EOR-22-0103.xml
16. Fujisawa Y, Masuhara K, Shiomi S. The effect of high tibial osteotomy on osteoarthritis of the knee. An arthroscopic study of 54 knee joints. *Orthop Clin North Am* 1979; 10(3): 585-608. PMID: 460834.
17. Hernigou P, Queinnec S, Picard L, Guissou I, Naanaa T, Duffiet P, *et al*. Safety of a novel high tibial osteotomy locked plate fixation for immediate full weight-bearing: a case-control study. *Int Orthop* 2013; 37(12): 2377-2384. doi: 10.1007/s00264-013-2066-3.
18. Gstöttner M, Pedross F, Liebensteiner M, Bach C. Long-term outcome after high tibial osteotomy. *Arch Orthop Trauma Surg* 2008; 128(3): 345-345. doi: 10.1007/s00402-008-0569-y.
19. Benayoun M, Langlais T, Laurent R, Le Hanneur M, Vialle R, Bachy M, *et al*. 3D planning and patient-specific surgical guides in forearm osteotomy in children: Radiographic accuracy and clinical morbidity. *Orthop Traumatol Surg Res* 2022; 108(6): 102925. doi: 10.1016/j.otsr.2021.102925.