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Case Series

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Medial opening-wedge high tibial osteotomy with dynamic axial external fixation in varus knee osteoarthritis: a prospective case series

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ABSTRACT

Varus malalignment in medial compartment osteoarthritis increases load transmission through the diseased compartment, accelerating symptomatic and structural degeneration. High tibial osteotomy remains a joint-preserving option in carefully selected younger and active patients, and dynamic axial external fixation permits gradual, controlled correction while avoiding retained internal implants. This prospective case series included 10 patients (8 women and 2 men) aged 35-55 years with symptomatic medial compartment osteoarthritis and varus deformity. All patients underwent medial opening-wedge high tibial osteotomy below the tibial tuberosity, stabilized with a dynamic axial external fixator. Gradual correction was initiated on postoperative day 7 at approximately 1 mm/day, typically through four incremental adjustments of 0.25 mm every 6 hours, and patients were mobilized early with walker support. Clinical outcomes were assessed using the visual analog scale for pain, the knee injury and Osteoarthritis Outcome Score pain and function subscales, and the Oxford knee score, with a minimum follow-up of 12 months. The mean correction achieved was 8-10 degrees of valgus, with radiological union occurring within 8-12 weeks. The mean VAS pain score improved from 6.8±0.9 preoperatively to 1.6±0.7 at 12 months; KOOS pain improved from 54.2±6.1 to 82.4±5.8, KOOS function from 51.6±5.4 to 79.7±6.2, and the Oxford knee score from 19.4±3.2 to 39.6±3.5. No pin-tract infection, fixation failure, loss of correction, or neurovascular injury was observed. One patient sustained a lateral cortex fracture classified as Takeuchi type II, without compromise to eventual union or need for conversion to alternative fixation. This case series describes an initial experience with dynamic axial external fixator-assisted high tibial osteotomy, demonstrating controlled correction, radiological union within the observed period, and a limited complication profile in this selected cohort; larger studies with longer follow-up and complete patient-level radiographic data are warranted.

Keywords: High tibial osteotomy, External fixator, Varus deformity, Medial compartment osteoarthritis, Takeuchi classification

INTRODUCTION

Medial compartment osteoarthritis of the knee is a common cause of pain, limping, and functional limitation among middle-aged adults. Varus malalignment shifts the mechanical axis medially, disproportionately increasing load transmission through the affected compartment and accelerating the degenerative process. Correction of the coronal plane deformity is therefore a central therapeutic goal in itself, rather than merely radiographic endpoint.[1-3]

High tibial osteotomy has a long-established role in the management of unicompartmental knee osteoarthritis. Early studies established the underlying rationale-unloading the diseased compartment by transferring the mechanical axis laterally-while subsequent long-term series demonstrated that appropriate patient selection and preservation of native joint mechanics are more critical determinants of outcome than the specific osteotomy technique employed. Contemporary reviews continue to support high tibial osteotomy as a durable, joint-preserving

procedure in young, active patients with isolated medial compartment disease.[4-7]

Open-wedge techniques offer the advantage of controlled, accurate correction while preserving tibial bone stock. Dynamic axial external fixation, hemicallotasis, and fixator-cum-distractor constructs permit gradual postoperative adjustment, reducing the risk of overcorrection and allowing fine-tuning of alignment. Comparative studies have reported outcomes broadly equivalent to plate fixation, although pin-tract infection remains the most widely recognized limitation of external fixation.[8-13]

Lateral hinge fracture represents one of the most significant technical complications of medial opening-wedge osteotomy. The Takeuchi classification remains the most widely used framework, as it correlates the pattern of lateral cortical failure with construct stability and guides clinical decision-making. Its relevance has been reinforced by biomechanical evidence confirming that hinge morphology and fracture type influence load transfer and healing potential.[15-18]

The present case series was undertaken to report our initial experience with medial opening-wedge high tibial osteotomy stabilized with a dynamic axial external fixator, and to contextualize these findings within the current literature on varus knee correction.

CASE SERIES

This descriptive case series included 10 patients (8 women and 2 men) with symptomatic medial compartment osteoarthritis and varus deformity of the knee. Patients ranged in age from 35 to 55 years, and all completed a minimum follow-up of 12 months. The cohort represented the institution's initial experience with this fixation technique and was followed closely for correction, union, clinical outcomes, and complications. The primary surgical goals were to restore mechanical alignment, unload the medial compartment, improve pain and function, and avoid retained internal implants.

Patients were selected when the clinical presentation was consistent with isolated medial compartment disease and the deformity was judged suitable for joint-preserving correction. The preoperative standing radiograph demonstrating varus malalignment and the marked mechanical axis is shown in Figure 1.

All patients underwent a medial opening-wedge high tibial osteotomy performed below the tibial tuberosity, followed by stabilization with a dynamic axial external fixator. The sequential intraoperative steps of osteotomy, fixation, and fluoroscopic assessment are shown in Figure 2. Gradual correction was initiated on postoperative day 7 at approximately 1 mm per day, typically achieved through four incremental adjustments of 0.25 mm every 6 hours. Patients were mobilized early with walker assistance, and the external fixator was retained until radiographic union was confirmed.



Figure 1: Preoperative standing radiograph demonstrating varus malalignment, with the mechanical axis marked.

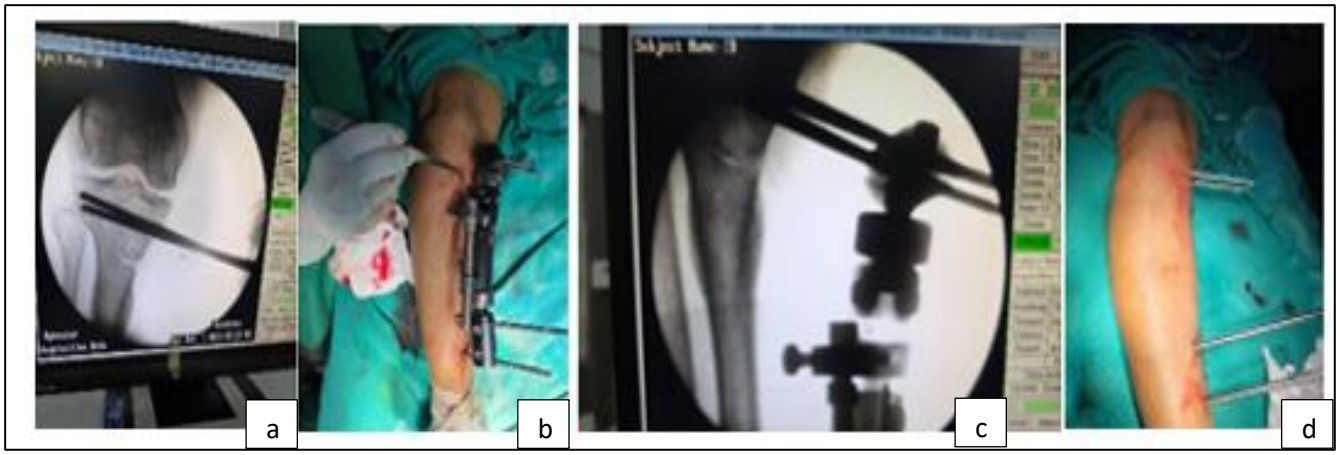


Figure 2 (a-d): Intraoperative images demonstrating the surgical procedure and correction achieved after 15 days of gradual distraction.

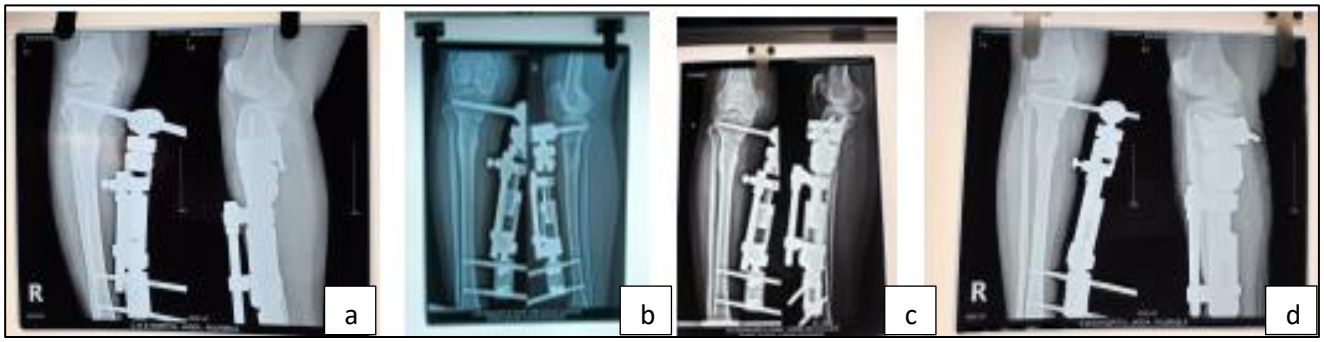


Figure 3 (a-b): Postoperative radiographic and clinical assessment after 15 days of gradual distraction with the dynamic axial external fixator *in situ*.

Postoperative radiographic and clinical assessment after 15 days of gradual distraction with the dynamic axial external fixator in situ is shown in Figure 3.

Clinical outcomes were assessed using the visual analog scale for pain, knee injury and osteoarthritis outcome score (KOOS) pain and function subscales, and the Oxford knee score. Radiological outcomes included the hip-knee-ankle angle and medial proximal tibial angle (MPTA) to quantify correction, along with time to union. All patients were also assessed for perioperative and postop complications.

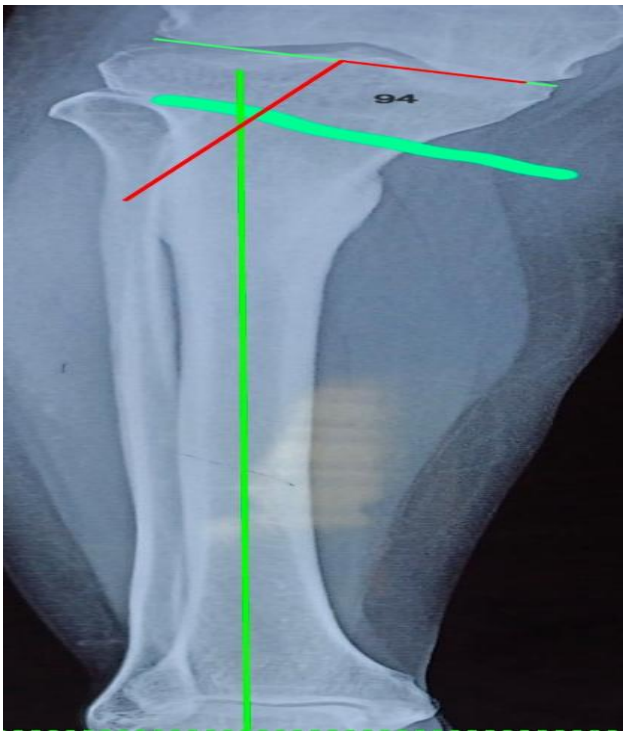


Figure 4: Radiograph demonstrating measurement of the medial proximal tibial angle (MPTA) used to quantify correction.

Complications were systematically recorded, with particular attention to pin-tract infection, loss of correction, implant or frame failure, neurovascular injury, delayed union, and lateral cortex fracture. Lateral hinge fractures were classified according to the Takeuchi classification. One fracture identified in this series was classified as Takeuchi type II.

Ten patients (8 women and 2 men) underwent the procedure, with an age range of 35-55 years and a minimum follow-up of 12 months. The mean correction achieved was 8-10 degrees of valgus, and radiological union occurred within 8-12 weeks. The correction range is reported as an aggregate because patient-level hip-knee-ankle angle and MPTA measurements were not available from the source data. Accordingly, individual radiographic values are not presented. No sex-based outcome comparison was attempted because the cohort included only two men; sex distribution is presented descriptively.



Figure 5 (a and b): Postoperative image showing deformative correction.

Clinical outcomes improved over the 12-month follow-up. The mean VAS pain score improved from 6.8±0.9 preoperatively to 1.6±0.7 at 12 months, while KOOS pain and function subscales improved from 54.2±6.1 to 82.4±5.8 and from 51.6±5.4 to 79.7±6.2, respectively. The Oxford knee score increased from 19.4±3.2 to 39.6±3.5 over the same period. No pin-tract infection, fixator failure, loss of correction, or neurovascular injury was observed. One patient sustained a lateral cortex fracture at the osteotomy site, classified as Takeuchi type II, which did not compromise eventual union or require conversion to an alternative fixation method.

Table 1: Demographic, operative, clinical, radiological and complication summary.

Parameters	Finding	Comments
Patients	10	8 women, 2 men
Age (in years)	35-55	All patients completed ≥12 months follow-up
Indication	Medial compartment OA with varus	Selected for joint-preserving correction
Procedure	Medial opening-wedge HTO	Performed below the tibial tuberosity
Fixation	Dynamic axial external fixator	Retained until radiographic union
Correction	8-10° valgus	Aggregate range; patient-level HKA/MPTA values unavailable
Radiological union	8-12 weeks	Observed across the cohort
VAS pain	6.8±0.9 → 1.6±0.7	Preoperative to 12 months
KOOS pain	54.2±6.1 → 82.4±5.8	Preoperative to 12 months
KOOS function	51.6±5.4 → 79.7±6.2	Preoperative to 12 months
Oxford knee score	19.4±3.2 → 39.6±3.5	Preoperative to 12 months
Complications	1 lateral cortex fracture	Takeuchi type II; no pin-tract infection, fixator failure, loss of correction, or neurovascular injury

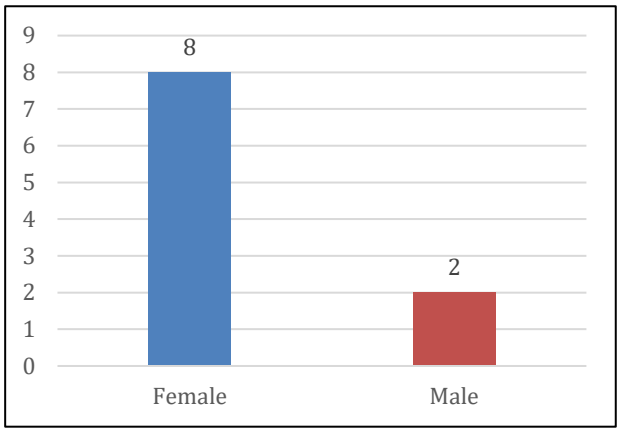


Figure 6: Gender distribution in the case series.

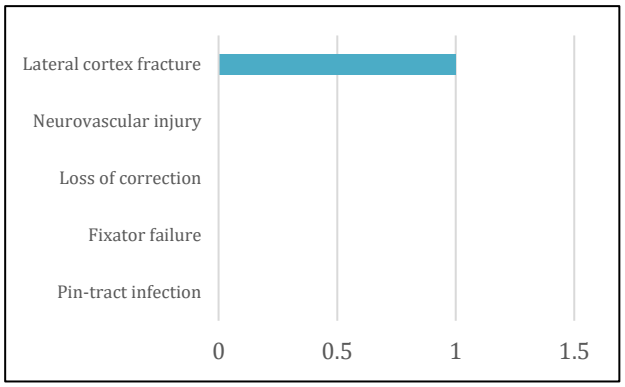


Figure 7: Reported complication profile.

DISCUSSION

The findings of present series suggest that dynamic axial external fixator-assisted high tibial osteotomy can achieve controlled coronal plane correction with low complication burden in a carefully selected group of younger patients. Correction range of 8-10 degrees and the union window of 8-12 weeks are consistent with the broad range reported in contemporary open-wedge series.[7,8,10,19,20]

The literature consistently supports high tibial osteotomy as a joint-preserving strategy rather than a purely pain-relieving procedure. Long-term series have demonstrated meaningful survivorship and patient-reported benefit when the operation is performed for the correct indication and with appropriate alignment planning. Systematic reviews similarly emphasize that the procedure remains durable in selected younger, active patients, whereas undercorrection, obesity, and technical error are associated with poorer outcomes.[1,3,21,22]

Our findings are also consistent with the literature comparing external fixation to plate fixation. Bachhal and colleagues reported precise alignment correction using a dynamic axial fixator, and comparative studies have found no major difference in functional outcome between fixator-based and plate-based techniques, although pin-tract infection has generally been more common with external fixation.[8-10] The absence of pin-tract infection in the present series should be interpreted cautiously given the small sample size.

The single lateral cortex fracture observed in this series merits particular attention, as it illustrates the clinical relevance of lateral hinge behavior in medial opening-wedge osteotomy. The Takeuchi classification remains the most practical framework for describing this complication, and subsequent biomechanical work has confirmed that fracture type and hinge length are associated with construct stability and risk of progression. A type II fracture does not necessarily indicate failure, but it warrants close radiographic surveillance and careful postoperative management.[18,19]

Open-wedge osteotomy can also influence tibial slope and patellofemoral mechanics; accordingly, radiographic planning should incorporate the hip-knee-ankle angle,

medial proximal tibial angle, and, where indicated, the sagittal plane profile. Systematic review evidence suggests that such changes are generally acceptable when correction is carefully planned and executed.[17-19]

Notable strengths of this case series include a clear surgical rationale, an implant-sparing technique, and applicability to resource-conscious clinical settings. Procedure is particularly relevant to younger patients in whom total knee replacement would be premature and joint-preserving alternative is considered. Its cost-effectiveness is a further consideration of practical relevance in this patient population.[5,6]

Several limitations warrant acknowledgment. Sample size is small and follow-up period, while sufficient to capture early alignment, union, and complication outcomes, remains short relative to longer-term survivorship data reported for joint-preserving procedures. This was a single-center, uncontrolled case series without comparator group, and formal statistical comparison between subgroups was not performed given limited cohort size. Individual patient-level radiographic measurements (HKA angle and MPTA) were not available for detailed reporting, and the reported correction range represents an aggregate estimate rather than patient-specific values. A larger, prospective, comparative study with complete radiographic and patient-reported outcome data would be needed to validate and extend these preliminary findings.

Overall, this series describes an early clinical experience in which the intended correction was achieved, union occurred within the observed time frame, and no major fixation-related failures were observed. The absence of infection and loss of correction should be interpreted in the context of the small, uncontrolled cohort.

CONCLUSION

Medial opening-wedge high tibial osteotomy stabilized with a dynamic axial external fixator represents a joint-preserving option for carefully selected patients with varus medial compartment osteoarthritis. In this series, the technique achieved controlled coronal plane correction, timely radiological union, and a limited overall complication profile, with a single lateral hinge fracture. These findings are preliminary; larger prospective cohorts incorporating standardized patient-reported outcome measures, complete radiographic alignment data, and longer-term follow-up would be required to substantiate and extend the evidence presented here.

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