Anterior Closing Wedge High Tibial Osteotomy and A Third ACL Reconstruction: Will These Patients Return to Impact Sports?

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Disclosures

Ahmed Mabrouk has no disclosures.

Matt Ollivier is a Newclip Consultant.

Background and Biomechanical Rationale

Steeper Posterior Tibial Slope

Increases anterior tibial translation and creates high shear forces on the ACL graft, increasing strain and failure risk

Anterior Closing Wedge HTO

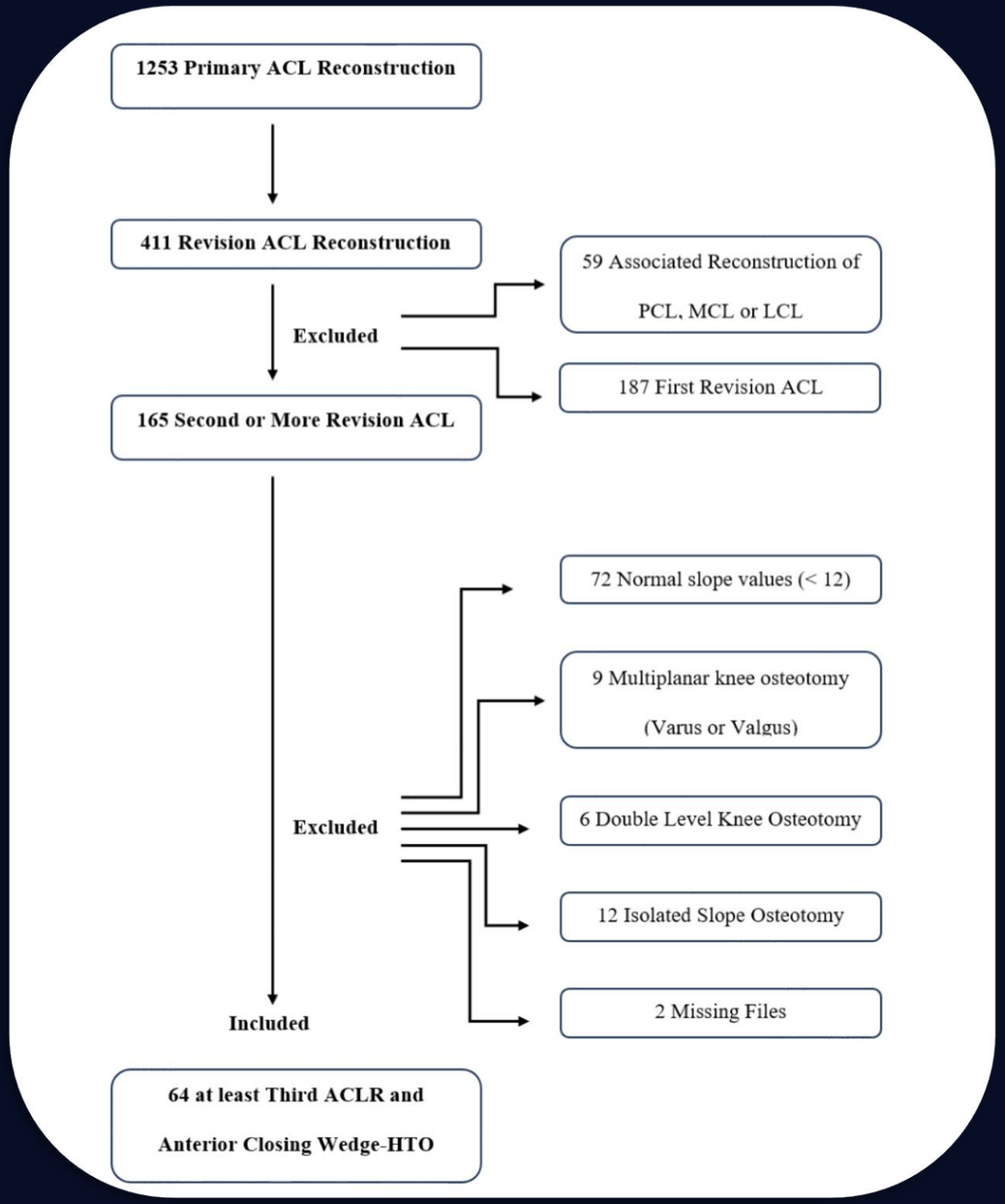
Recommended for revision cases with posterior tibial slope >12°, creating a flatter tibial plateau

Biomechanical Correction

ACL reconstruction addresses anteroposterior instability while osteotomy protects the new graft from excessive forces

Outcome Evaluation

Study reviews clinical, radiological, and return to sports outcomes following combined procedure



Patient Cohort and Methodology

1 Patient Selection

Candidates with multiple ACL failures and documented increased posterior tibial slope (>12°) were identified through comprehensive clinical evaluation and radiographic assessment

2 Surgical Intervention

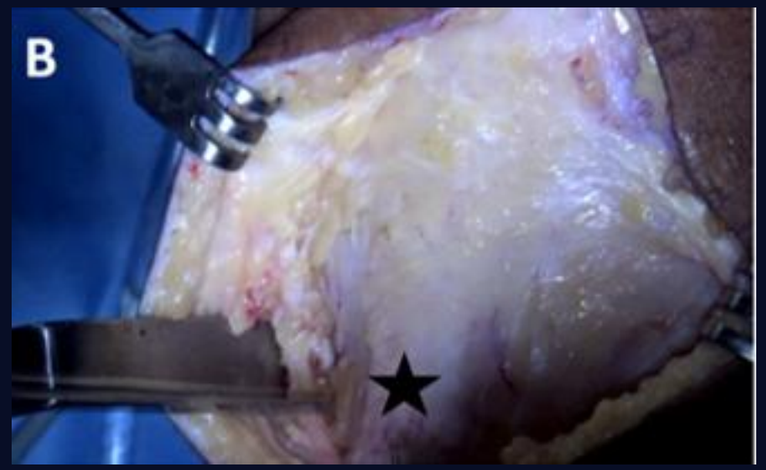
Combined anterior closing wedge high tibial osteotomy with revision ACL reconstruction performed by experienced knee surgeons following standardised protocol

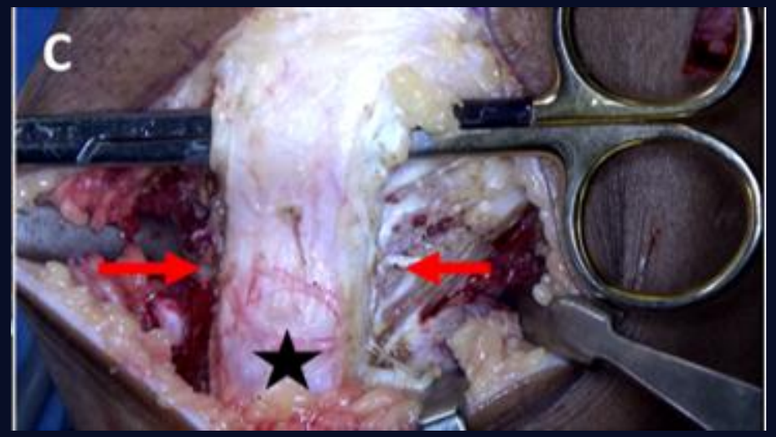
3 Outcome Measures

Clinical evaluation included GNRB arthrometer measurements, UCLA activity scale, Lysholm and IKDC scores, and detailed radiographic analysis of slope correction

4 Return to Sport Analysis

Patients were followed prospectively to document their ability to return to pre-injury sporting activities with detailed activity level stratification





Surgical Approach and Technique

Initial Incision and Exposure

A 10-cm incision is planned starting just proximal to the tibial tubercle, allowing adequate exposure of the proximal tibia. This approach provides optimal visualisation for both the osteotomy and tunnel placement for ACL reconstruction.

Soft Tissue Management

Medial and lateral skin flaps are raised, followed by careful dissection of the patellar tendon from the medial and lateral capsule. A straight clamp defines the proximal aspect of the tibial tubercle.

Subperiosteal Exposure

Subperiosteal flaps are meticulously raised to expose the proximal tibia both medially and laterally, creating the necessary surgical field for precise osteotomy and hardware placement.

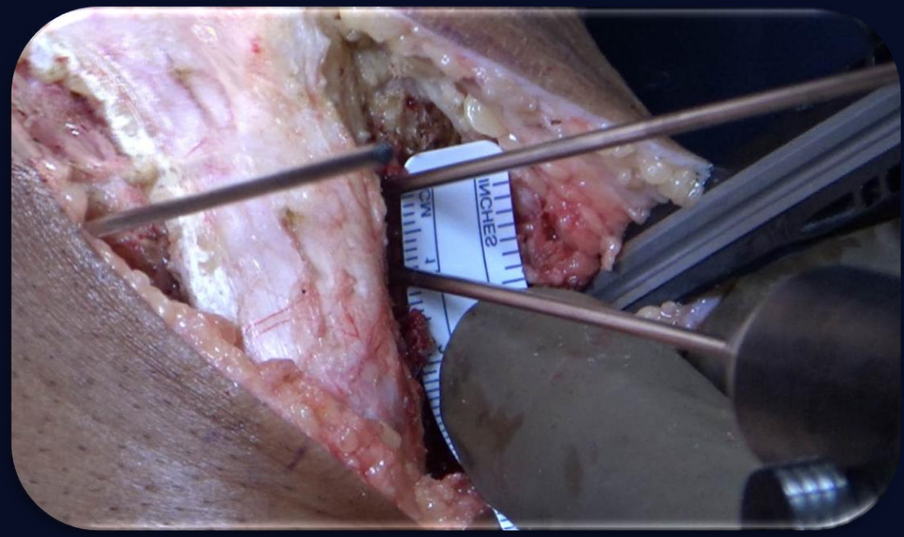
Osteotomy Planning and Execution

Guidewire Placement

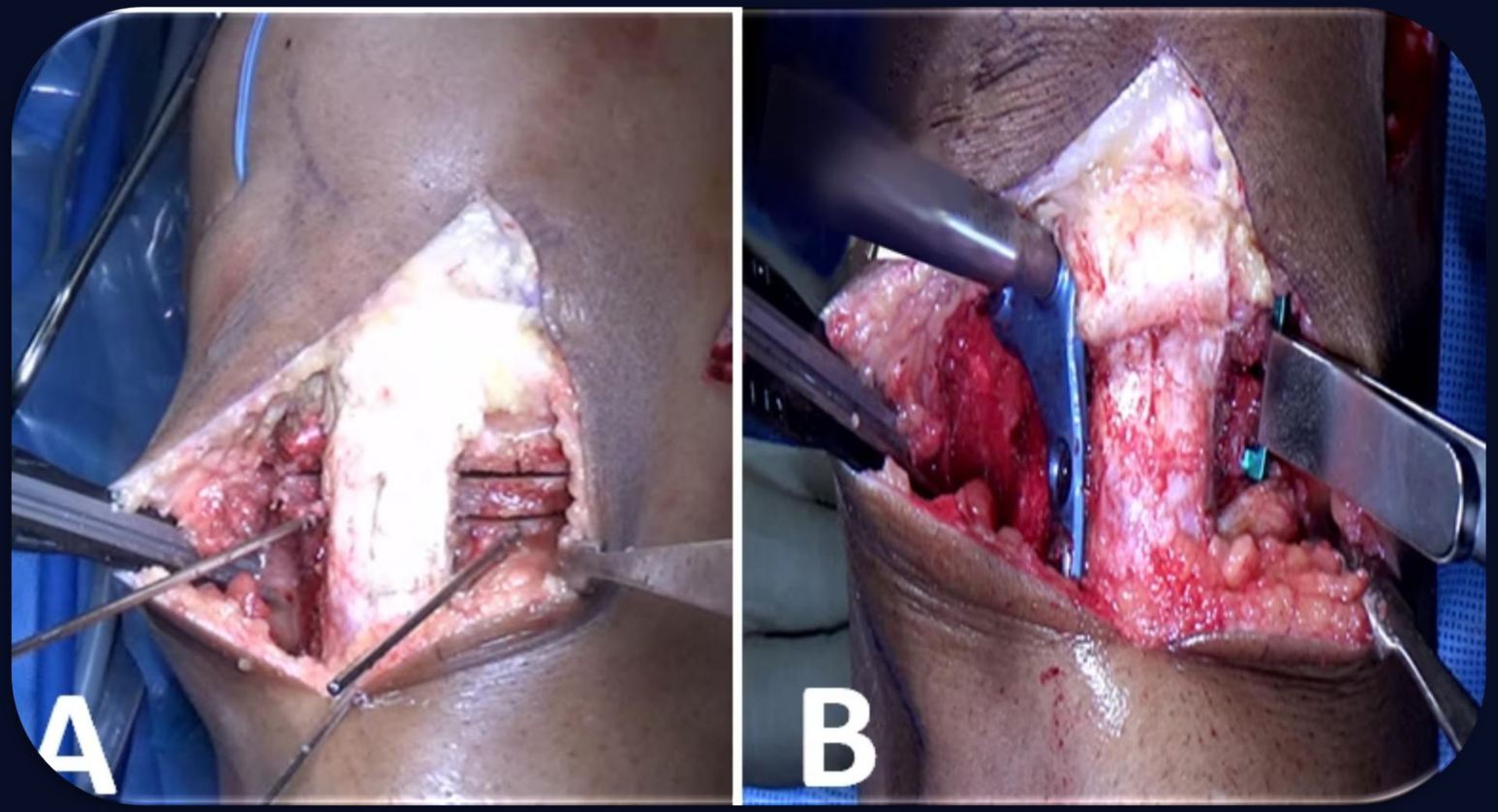
Precise placement of proximal and distal guidewires to define the osteotomy

Wedge Calculation

Distance between wire sets equals planned closing wedge base



Surgical Technique and Fixation



Wedge Creation

The anterior closing wedge osteotomy is meticulously created with the wedge initially left in situ to verify the geometry and planned correction. This step allows for fine adjustments before final closure.

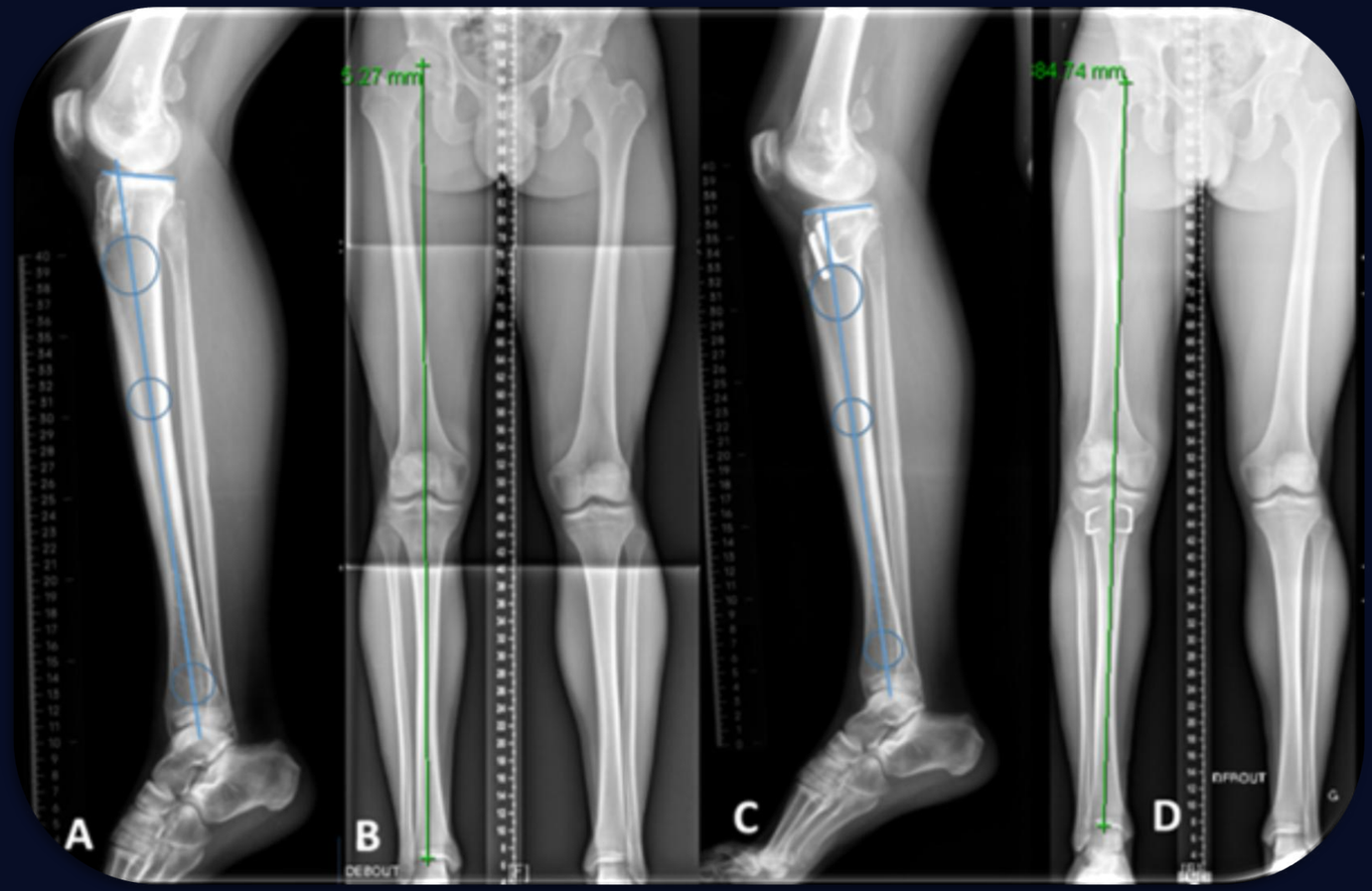
The size of the wedge is precisely calculated based on preoperative measurements to achieve the desired posterior tibial slope reduction, typically targeting a final slope of 4-5°.

Fixation Strategy

Robust fixation is achieved using a dual approach: staples on the lateral side provide compression whilst a locked plate on the medial side ensures rotational stability and prevents displacement.

This fixation technique allows for early rehabilitation whilst maintaining the corrected slope until bony union is achieved. Hardware removal was performed in 31 patients, with only 11 reporting hardware discomfort.

Radiographic Assessment



Preoperative Assessment

Lateral view showing increased posterior tibial slope measurement using the circle of best-fit method. Long-standing radiographs with Mikulicz line demonstrate neutral alignment in the coronal plane.

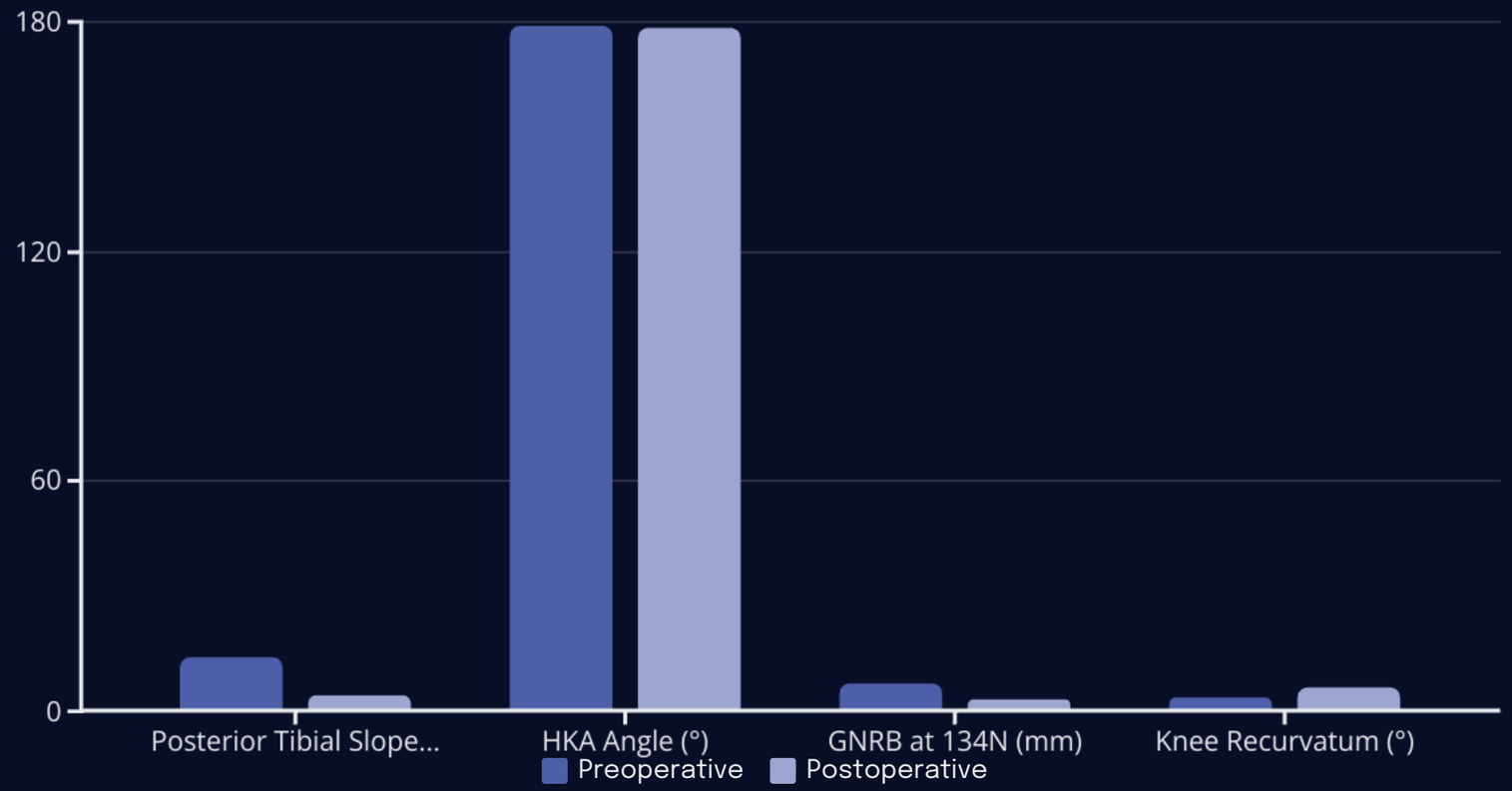
Planning Phase

Digital preoperative planning determines precise wedge size and location to achieve target slope correction whilst maintaining neutral coronal alignment.

Postoperative Result

Lateral view showing the ACW-HTO fixed with staples and significantly reduced PTS. Postoperative long-standing radiographs confirm maintenance of neutral alignment in the coronal plane.

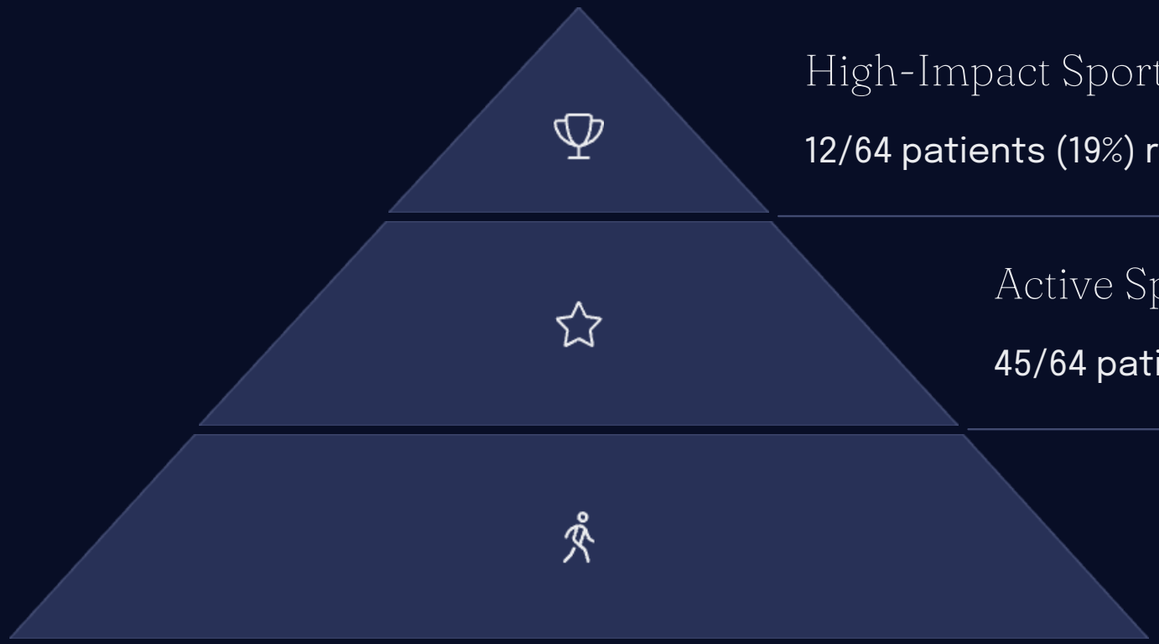
Clinical and Radiological Outcomes



The intervention produced a significant posterior tibial slope reduction from 13.8° ± 1.5° to 4.2° ± 1.7° ($p < 0.0001$), without meaningful changes to coronal alignment. Anterior knee laxity measured by GNRB arthrometer showed substantial improvement at both 134N and 250N testing parameters.

A notable finding was the increase in knee recurvatum by 2.58° ± 0.64° postoperatively ($p < 0.0001$), although all patients remained asymptomatic. No instances of non-union, delayed union or posterior cortical hinge violation were observed.

Return to Sport and Functional Outcomes



High-Impact Sports

12/64 patients (19%) returned vs 30/64 preinjury

Active Sports

45/64 patients (70%) returned vs 58/64 preinjury

Moderate Activity

52/64 patients (81%) returned vs 64/64 preinjury

All patient-reported outcome measures showed significant improvement ($P < 0.0001$) from preoperative baseline, including UCLA activity scale, Lysholm, and IKDC scores. However, these scores did not return to preinjury levels ($P < 0.0001$), suggesting some residual functional limitations.

The most notable finding was the limited return to high-impact sports, with only 19% of patients resuming activities like football or basketball. This suggests that whilst the combined procedure effectively restores basic knee stability, patients should be counselled about realistic expectations regarding high-demand activities.

Conclusions and Clinical Implications

Efficacy of Combined Approach

Posterior tibial slope reduction via ACW-HTO combined with revision ACL reconstruction successfully restores knee stability and improves function in patients with chronic ACL deficiency and increased slope.

Complications Profile

Increased knee recurvatum was observed in approximately one-third of patients, though all remained asymptomatic. No major complications such as non-union or hardware failure were reported.

Return to Sport Expectations

Less than half of the patients returned to high-impact sports, suggesting that realistic counselling about activity restrictions is essential when considering this procedure.

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Ahmed Mabrouk, Matthieu Ollivier (Marseille , France)

Introduction

A steeper PTS increases anterior tibial translation with resultant high shear forces and strain on the ACL. Whereas, a more flat PTS will reduce the ACL tensile forces and alternatively load the posterior cruciate ligament [3,4,37,48,57].

Hence, in the revision cases, several authors recommended concomitant ACLR and slope reduction osteotomy by anterior closed-wedge high tibial osteotomy (ACW-HTO) for patients with ACL rupture and PTS values greater than 12° [10,32,48].

While ACLR addresses the anteroposterior knee instability and targets correcting the biomechanics, the ACW-HTO serves the protection of the new graft from increased shear forces of the increased PTS [43].

This study reviews the outcomes of patients who had PTS reduction with ACW-HTO and concomitant revision ACLR. Clinical, radiological, and return to sports outcomes were evaluated.

Patients and Methods

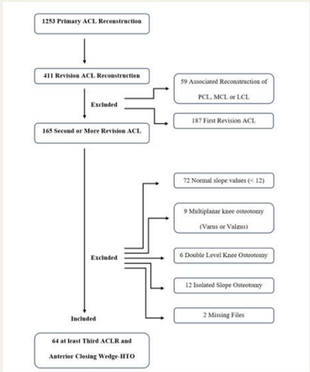

Figure 1: Patient Flow Chart

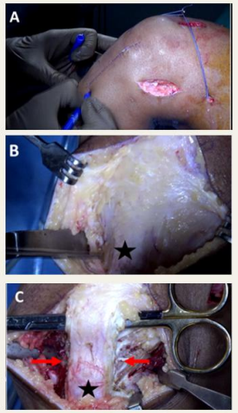

Figure 2: Surgical approach on a left knee. **A)** Planning a 10-cm incision starting just proximal to tibial tubercle . B) Medial & lateral skin flaps are raised. C) Patellar tendon (Black star) is dissected from the medial and lateral capsule, and a straight clamp is used to define the proximal aspect of the tibial tubercle, then subperiosteal flaps are raised to expose the proximal tibia medially and laterally (Red arrows).

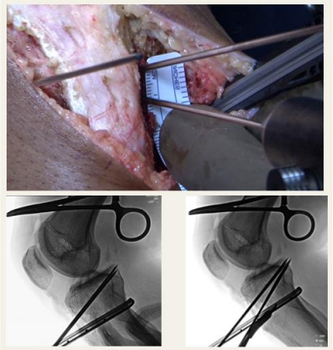

Figure 3: The distance between the two sets of guidewires should be equal to the planned closing wedge base. The distal set of the guidewires should be converged to the proximal set to meet at the hinge point proximally.

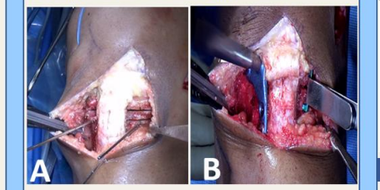

Figure 4: A) Anterior knee image showing the anterior closing wedge osteotomy is created with the wedge insitu. **B)** Positioning a staples on the lateral side and a locked plate on the medial side

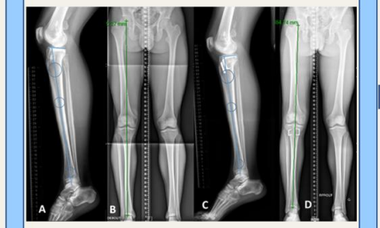

Figure 5: A) Preoperative lateral view of the right tibia and fibula showing estimation of the PTS based on the circle of the best-fit method. **B)** Preoperative LSRs with Mikulicz line drawn demonstrating neutral knee alignment in the coronal plane. **C)** Postoperative lateral view of the right tibia and fibula showing the performed ACW-HTO fixed with 2 staples, and estimation of the PTS based on the circle of the best-fit method. **D)** Postoperative LSRs demonstrating neutral coronal alignment.

Results

The average change in the posterior tibial slope was 9.5 ± 0.3°, which reflected a significant change from the preoperative slope of 13.8 ± 1.5 ° to the postoperative of 4.2 ± 1.7 ° (p< 0.0001).

There was nWhereasmajor coronal plane deformity preoperatively, and no change in the coronal plane alignment postoperatively, with a preoperative measured Hip-Knee-Ankle angle (HKA) of 179.14 °± 0.24 ° to postoperative HKA of 178.52 °± 0.24 °.

The mean Δ anterior knee laxity measurement using GNRB arthrometer at 134 N, was - 4.03 ± 0.18, from preoperative of 6.96 ± 1.19 to postoperative of 2.93 ± 0.83. And the Δ GNRB measurement at 250 N was – 3.63 ± 0.16, from preoperative 7.10 ± 0.74 to postoperative 3.46 ± 1.12.

Preinjury, all patients, 64/64 were involved in moderate sports activity (UCLA > 5) versus 52/64 patients, postoperatively. And 58/64 patients were regularly participating in active events such as cycling (UCLA > 6) versus 45/64 patients, postoperatively. Whereas 30/64 patients were involved in high-impact sports (UCLA 9 – 10) versus 12/64 patients, postoperatively.

Patient Reported Outcome Measures (PROMs)

All patient-reported outcome measures: UCLA activity scale, Lysholm, and IKDC improved significantly (P < 0.0001) relative to the preoperative measures. However, all the scores did not equate to the preinjury values (P < 0.0001).

Postoperative characteristics (Number of patients/64)	
Return to moderate activity sports (UCLA > 5)	52
Return to regularly active sports (UCLA > 6)	45
Return to pivoting and high-impact sports (UCLA 9 to 10)	12
Return to preinjury level	16

Number of patients returning to sports postoperatively.

Complications

There was an increase in the postoperative knee recurvatum of 2.58 ° ± 0.64 °, from preoperative 3.67 ° ± 3.59 ° to postoperative 6.25 ° ± 3.75 ° (p < 0.0001). There was no reported violation of the posterior cortical hinge in any of the cases. There was no reported osteotomy site non-union or delayed union. There were no hardware complications, however, 31 patients had the removal of hardware based on their preference. Eleven of these patients reported hardware discomfort.

Conclusion

In the setting of chronic ACL deficient knees, posterior tibial slope reduction (ACW-HTO) with revision anterior cruciate ligament reconstruction will restore knee stability and improves function with an acceptable rate of specific complications. Increased knee recurvatum was observed in a third of the patients, but all were asymptomatic. And less than half of the patients were able to return to high-impact sports.

References

Outcomes of Slope-Reducing Proximal Tibial Osteotomy Combined With a Third Anterior Cruciate Ligament Reconstruction Procedure With a Focus on Return to Impact Sports. Mabrouk A, *Kley K, Jacquet C, Fayard JM, An JS, Ollivier M. Am J Sports Med. 2023 Nov;51(13):3454–63.* ***DOI:*** *10.1177/03635465231203016*

Reference: Mabrouk A, Kley K, Jacquet C, et al. Outcomes of Slope-Reducing Proximal Tibial Osteotomy Combined With a Third ACL Reconstruction. Am J Sports Med. 2023;51(13):3454-63.