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Technical Paper

Vertical Midtrans-Patellar Arthrotomy Approach for Total Knee Arthroplasty: A Biologically Coherent Full Extensor-Preserving Exposure Strategy

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Abstract

This article describes a vertical midtrans-patellar osteotomy technique for surgical exposure in total knee arthroplasty (TKA). The method represents a bone-based exposure strategy designed to preserve extensor mechanism continuity and micro anatomical integrity while restoring patellar structure through compression bone healing. The osteotomy incorporates a full-length interlocking vertical configuration that preserves medial and lateral stabilizers integrity and allows symmetrical, wide joint exposure. A fundamental principle of the technique is that fixation trajectories are established before initiating the osteotomy, while the patella is still anatomically intact. Predrilled parallel fixation trajectories and the interlocking vertical osteotomy configuration together create a mechanically guided reduction system that restores anatomical patellar articular surface alignment during closure with rigid fixation. By avoiding transection of the medial patellar stabilizers, preserving extensor mechanism continuity, and reconstructing the patella through compression fixation of bone rather than tendon-ligament repair, the technique may facilitate a complete restoration of extensor mechanism integrity, which could theoretically reduce postoperative quadriceps inhibition and promote improved functional recovery. Quadriceps weakness following total knee arthroplasty has been well documented and frequently persists despite adequate postoperative rehabilitation. Cadaveric validation demonstrated an absence of fluid leakage across the osteotomy and tendons fibres spreading interface under progressive saline injection volumes and repeated flexion cycles at varying angles, whereas conventional medial parapatellar arthrotomy specimens demonstrated seepage under similar conditions at the suture sites in the distal pretibial segment of the arthrotomy. An animated surgical video demonstrating the operative steps accompanies this report.

Keywords: *knee arthroplasty, surgical approach, Vertical mid-patellar osteotomy, trans-patellar arthrotomy,*

Introduction

The medial parapatellar arthrotomy remains the most widely used exposure for total knee arthroplasty. Although reliable and extensile, it requires selective division of medial extensor structures and may fundamentally alter the natural finely tuned medial-lateral stability balance of the extensor mechanism [1,2].

The present technique demonstrates a bone-based alternative exposure using a full-length interlocking vertical mid-patellar osteotomy configuration. The objective is to preserve longitudinal extensor's units' continuity while maintaining medial-lateral stabilizer integrity and enabling straightforward, symmetrical wide joint exposure. Because closure occurs through compression fixation of bone rather than repair of divided tendon and medial patellar femoral ligament's fibers, restoration of structural continuity relies on primary bone healing.

Indications and Contraindications

Indications

- Primary or revision TKA not requiring patellar resurfacing
- Preserved patellar bone stock
- Severe knee deformity requiring enhanced exposure
- Obese patients in whom lateral translation of the patella is difficult and exposure is compromised
- Selected complex revision TKA cases
- Comminuted osteoporotic distal femoral fractures requiring combined intra- and extramedullary fixation
- Eventualy for bi cruciate-retaining TKA.

Contraindications

- Severe patellofemoral degeneration requiring resurfacing
- Markedly osteoporotic patella
- Prior patellar fracture with malunion
- Preoperative Planning

Preoperative Planning

AP, lateral, and sunrise view radiographs are obtained to evaluate patellar morphology and thickness. Adequate patellar bone stock must be present to allow safe osteotomy execution and fixation. Intraoperative awareness of the pre-measured patellar thickness assists in calibrating blade depth and confirming osteotomy depth at the subchondral level without cartilage penetration. CT-based planning may be particularly useful in revision cases, dysplastic patellae, or when bone stock appears limited on standard radiographs.

Patient Positioning

The patient is positioned supine with a standard thigh tourniquet applied. The knee is stabilized at 60° of flexion using a lateral femoral support and a heel stopper. The limb is prepared and draped in the usual sterile fashion.

Overview of the Procedure

The technique follows a structured sequence designed to facilitate reproducible execution. Two parallel drill-bit wires are first placed to define the fixation trajectories while the patella is still anatomically intact. A dedicated adjustable parallel alignment guide (A) is used to control the entry and exit sites of those two wires. Cannulated predrilling is then performed along these wires.

Following longitudinal splitting of the quadriceps and patellar tendons, a dedicated cutting guide (B,C) is secured to the patella. A full-thickness vertical osteotomy with an interlocking configuration is then performed. Controlled separation of the patellar halves is achieved using dual chisels (D) inserted along the interlocking osteotomy plane.

Surgical Technique

Exposure

1. Parallel Drill-Bit Wire Placement: Two drill-bit wires are placed strictly parallel in the coronal and transverse planes, using a dedicated parallel dual drilling guide (A) that allows precise visual control of the exit locations. The guide (A) is then removed. Cannulated drilling is subsequently performed using these parallel wires while the patella is still anatomically intact. These trajectories predetermine the definitive screw fixation sites.

2. Longitudinal Tendon Split: Full-thickness longitudinal midline splitting of the quadriceps and patellar tendons is performed first, along the osteotomy axis. A flexible subpatellar padding is introduced through the proximal tenotomy to protect the trochlear cartilage, with the knee in full extension.

3. Cutting Guide Fixation: The knee is stabilized at 60° of flexion by resting the heel on the stopper. This position increases patellar stability by maintaining patellar engagement within the trochlear groove. A dedicated cutting guide (B-C) with a tall, vertical "Z"-shaped central slot, designed to conform to the rounded anterior patellar surface, is centered on the patella. Prior to its fixation, special attention is given to aligning both extremities of the cutting guide slot with the proximal and distal tendon splitting. The cutting guide is then secured by introducing four short K-wires at 45° through its corners and beyond the patellar cortex.

4. Osteotomy Execution: A guided partial-thickness osteotomy using the cutting guide (C) is performed perpendicular to the rounded anterior patellar cortex using a thin oscillating blade under continuous irrigation, with progressive advancement toward the subchondral bone. Because the distal third of the patella is typically thinner than the proximal two-thirds, particular attention must be paid to the risk of premature joint penetration in this region. Because the patella is subjected to high compressive forces, it is known to be one of the densest bones in the human body; to maintain precise tactile feedback while cutting dense cancellous bone, the blade should be replaced when cutting efficiency diminishes. At that point, the cutting guide should be removed. Once the subchondral layer is reached, the remaining cortical bone is gently weakened by light tapping with the oscillating cutting blade, almost completing the full-thickness osteotomy.

5. Controlled Dual Chisel Separation: Two long, ultra-thin, single-beveled chisels (D) are introduced side by side along the osteotomy plane. After initial gentle reciprocal chisel tapping and gradual bone weakening, the knee is slowly flexed from 60° toward 90°. The surgeon visually monitors the osteotomy opening to confirm bilateral passive separation produced by symmetrical tensioning of medial and lateral attachments and to detect any unintended fracture propagation. The use of a sharp knife blade may help control separation of the thick cartilage along the desired plane, especially at the tips of both angles of the interlocking configuration, where residual resistance may prevent complete separation.

Closure Technique

6. Alignment Wire Reduction: First, the knee is fully extended, and two high-strength sutures are temporarily applied to both tendons at each patellar extremity without definitive locking stitches. They are used to temporarily approximate the two patellar halves side by side, reducing the separation to less than 1 cm. Two Kirschner wires equal to or smaller than the screw diameter are introduced into the predrilled trajectories. This allows to achieve sagittal, coronal and transverse alignment. Two bone forceps are applied and alternately tightened to build and maintain maximal temporary compression. The quality of intra-articular reduction can be assessed by digital palpation through the quadriceps tendon split during progressive forceps compression.

7. Definitive Fixation: Two headless, variable-pitch cannulated compression screws are inserted and tightened alternately along the same trajectories to achieve symmetrical final compression before removing the forceps. Articular congruency is once again confirmed with the knee in full extension prior to final screw tightening. Tendon splits are repaired separately using running sutures.

A complete three-dimensional demonstration of the surgical sequence is provided as Supplementary Video 1.

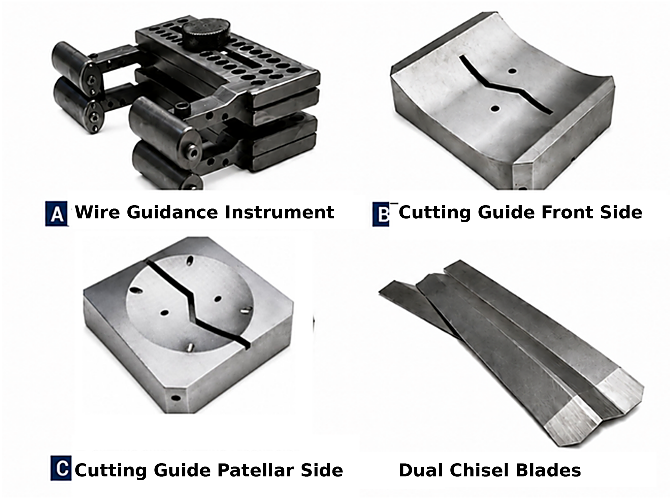

Figure 1. Dedicated instrumentation, shown once in chronological order of use: (A) wire-guidance instrument; (B) cutting guide, patellar side; (C) cutting guide, cutting/front side; (D) dual chisel blades. The operative steps above refer to these letter designations.

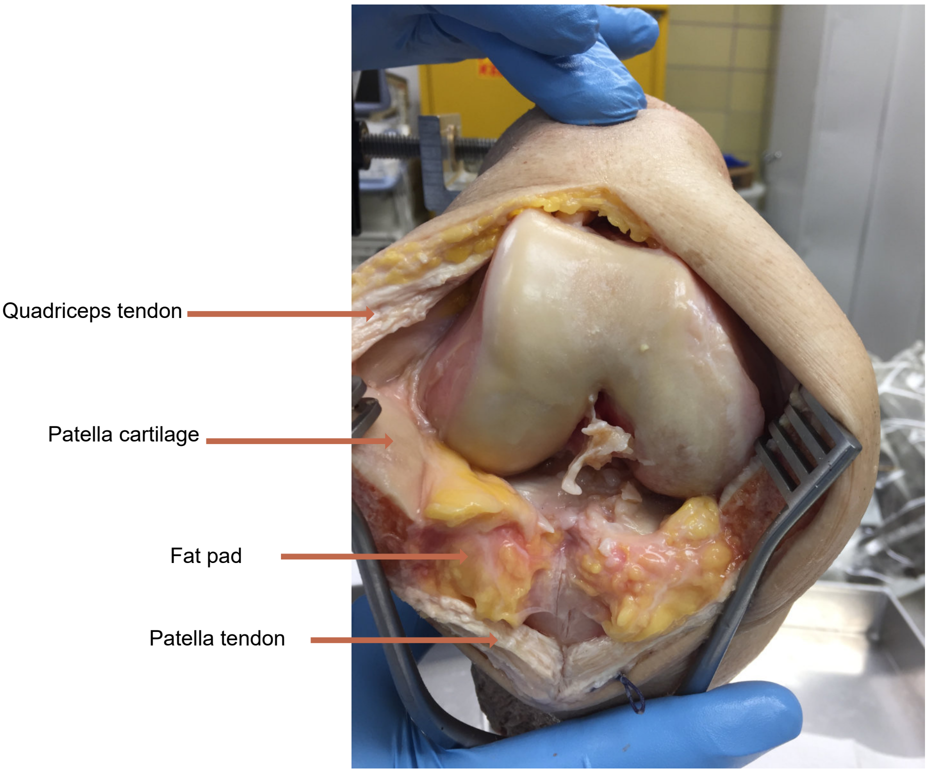

Figure 2. Wide symmetrical operative exposure obtained with the vertical mid-patellar arthrotomy technique.

Technical Validation & Biomechanical Considerations

Four fresh-frozen cadaveric knees underwent the surgical sequence described above, and four others underwent a conventional medial parapatellar arthrotomy. Following closure, 40, 60, and 90 mL of saline were injected in the articular space. Knees were subjected to repeated 5 passive flexion cycles at 60°, 90°, and 120°. Leakage was defined as visible fluid extrusion from the suture holes and closure interface. Most evident in the distal pretibial segment of the capsular arthrotomy. No visible leakage was observed in any of the osteotomy specimens, whereas conventional medial parapatellar arthrotomy specimens demonstrated leakage under comparable conditions, most evident in the distal pretibial segment of the capsular arthrotomy. Intra-articular pressure dynamics are known to vary with knee flexion and joint distension.

The vertical midline configuration preserves medial-lateral stabilizer integrity. Unlike selective medial division, this approach maintains the preoperatively balanced transverse tension distribution during passive and active flexion and extension. The interlocking geometry increases contact surface area and resists shear forces. Parallel compression screws provide axial compression, promoting rigid fixation and primary bone healing. In contrast, tendon and ligamentous repair relies on a slower scar-mediated soft tissue healing process with altered elasticity. By preserving longitudinal continuity of the ‘’quadriceps – patella - patellar tendon extensor unit’’, maintaining medial-lateral stabilizer integrity, and relying on compression-based primary bone healing, this described technique may be considered a mechanically and biologically coherent access strategy.

Expected Outcomes and Postoperative Management

This feasibility study demonstrates a novel means of achieving wide surgical access to the knee, with stable fixation and no visible leakage under the tested conditions. The technique may allow restoration of extensor mechanism integrity while maintaining patellar congruity and stability. Standard postoperative rehabilitation following total knee arthroplasty is recommended. Further clinical investigation is necessary to determine long-term outcomes.

Technical Pearls and Pitfalls

Technical Pearls

- Strict wire parallelism
- Predrilling before osteotomy
- Use thin blades with continuous irrigation, replacing them as needed
- Increasing flexion to 90° during initial passive separation
- Alignment-wire reduction before compression fixation
- Intra-articular digital confirmation of congruency before final tightening

Technical Pitfalls

- Premature extra-articular or intra-articular exit of wire trajectory
- Excessive manual levering during separation
- Divergent splitting caused by incomplete osteotomy sectioning
- Loss of wire parallelism
- Insufficient patellar bone stock
- Joint surface incongruency resulting from asymmetric compression

Discussion and Conclusion

While the quadriceps snip and tibial tubercle osteotomy are well-established extensile approaches for total knee arthroplasty, they inherently involve significant soft tissue or structural modifications [3,4]. In contrast, the present technique demonstrates a reproducible, bone-based exposure strategy that preserves the longitudinal continuity of the extensor mechanism, building upon previous bone-based approaches to the knee [5,6].

The patella possesses a rich vascular supply derived from an extensive peripatellar anastomotic arterial network [10]. Consistent with this vascularity, nonunion following surgical treatment of patellar fractures is uncommon, with a meta-analysis of 464 surgically treated fractures reporting a nonunion rate of 1.3% [11]. Importantly, Donald and Bateman reported no cases of nonunion following their oblique patellar osteotomy [6], providing further clinical support for the healing potential of patellar osteotomy.

This approach not only offers a symmetrical, wide surgical exposure but also promotes the restoration of extensor mechanism integrity. In our cadaveric study, compressive fixation of the patella demonstrated less leakage than sutured medial parapatellar arthrotomy under the tested conditions, potentially reducing the risk of postoperative wound drainage [7].

Because optimal quadriceps function depends ultimately on the mechanical and biological structural integrity of all the extensor mechanism's components including the neuro-muscular feedback system, using bone-based anatomical reconstruction rather than traditional medial tendon-ligament repair offers distinct biomechanical advantages [8]. Relying on primary bone healing instead of soft tissue scar healing avoids the prolonged rehabilitation pain's restrictions associated with tendon repairs and may theoretically reduce postoperative quadriceps inhibition, thereby facilitating a faster and more robust functional recovery [5,9]. Furthermore, by avoiding transection of the medial stabilizers, this technique may mitigate soft tissue trauma, thereby limiting pain and effusion-key catalysts known to drive arthrogenic muscle inhibition and delay muscular recovery [9].

Ultimately, this feasibility study demonstrates that the vertical mid-patellar arthrotomy provides novel, wide surgical access with stable fixation and no visible leakage under the tested conditions. By preserving structural anatomical continuity, the technique serves as a biologically and mechanically coherent strategy that maintains patellofemoral congruity and stability. While these foundational biomechanical principles are promising, further clinical investigation remains necessary to fully determine the long-term outcomes and in vivo efficacy of this approach.

In joint surgery, achieving optimal exposure while minimizing iatrogenic damage has long been a fundamental principle of preserving functional anatomy. Given the unique complexity of the knee extensor mechanism—and the importance of preserving the highly specialized structures responsible for medial dynamic stabilization and proprioception—the functional consequences of soft-tissue injury caused by conventional TKA exposure warrant critical examination. This concern supports the pursuit of a safer alternative approach that provides adequate surgical exposure while preserving these essential structures.

Conflict of Interest

The dual drilling guide, cutting guide and configuration adapted chisels used to standardize this osteotomy were developed by the author. No commercial sales or royalties have been received.

Supplementary Material

Supplementary 3D animated Video 1. Three-dimensional demonstration of the complete vertical mid-trans-patellar arthrotomy surgical technique, presented continuously from initial wire-guided preparation through osteotomy, controlled separation, reduction, and definitive fixation.

Accompanying file: Supplementary_Video_1_VMPO_3D_Technique.mp4

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