Innovative knee surgery: arthroscopic double bundle U-DOS reverse Technique for PCL tears

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ABSTRACT

The Double Bundle U-DOS Reverse Technique for posterior cruciate ligament (PCL) tears is a novel arthroscopic technique that combines two well-known procedures: the mono-tunnel approach and the medial-portal approach, provides better posterior stability, improved functional outcomes, and a reduced risk of posterior tibial subluxation. This technique allows for the simultaneous treatment of anterolateral and posteromedial bundles and has been successfully performed on 16 patients, with follow-up showing sufficient support and resistance to posterior tibial subluxation or excessive displacement, resulting in a stable knee joint.

1. Outline of the clinical problem

The posterior cruciate ligament (PCL) is one of the two cruciate ligaments in the knee. It acts as the main stabilising ligament of the knee in posterior translation. Additionally, the PCL contributes to limiting hyperextension and controlling internal rotation, adduction, and abduction of the knee joint. Isolated PCL injuries often occur in scenarios where direct impact is applied to the front area of the tibia while the knee is flexed at approximately 90°. These types of injuries are commonly observed in high-energy incidents, such as motor vehicle accidents or sports-related collisions. As a result of these traumas, the PCL may experience high-energy incidents, complete or partial tears, leading to compromised stability of the knee joint. These high-energy traumas can result in complete or partial tears of the PCL, affecting the knee's overall stability and leading to significant morbidity, including pain, instability, and impaired mobility [1,2].

2. Treatment options

Treatment depends on the type and extent of the injury. Acute treatment involves rest, ice, compression, elevation, and knee bracing. Surgery is recommended for acute injuries with tibial translation greater than 12 mm, chronic injuries with posterior tibial translation greater than 8 mm, and multiligamentous injuries. A thorough assessment of the patient's anatomy and the technical capabilities of the surgeon are necessary to determine the best surgical technique [3–7].

3. Surgical indications/contraindications

- Indications:
  - Complete PCL tears.
  - Chronic instability.
  - Failure of non-surgical treatments.
  - Young and/or active patients.

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Contraindications:
- Advanced osteoarthritis or severe joint degeneration.
- Infection/Poor general health.
- Previous knee surgery.

4. Current surgical techniques

Surgical techniques include single and double-bundle reconstruction, autograft or allograft, tibial inlay or transtibial techniques, and high tibial osteotomy (HTO) for chronic PCL-deficient knees and varus malalignment. Both single- and double-bundle techniques have limitations, and the optimal surgical approach remains a subject of ongoing debate. While the single-bundle technique may not fully restore normal biomechanics, the double-bundle technique may be technically challenging and time-consuming.

5. Novelty of the double bundle U-DOS Reverse Technique

- Reverse approach, creating double bundles for improved stability.
- Ability to address both the anterolateral and posteromedial bundles in one procedure.
- Reduced risk of posterior tibial subluxation.
- Improved functional outcomes.

The double-bundle U-Dos Reverse Technique was performed on 16 patients with medium- to high-grade PCL tears. All patients had MRIs confirming the diagnosis, and arthroscopic reconstruction was performed using a single tendon graft passing through two separate tunnels. The technique achieved knee stability with no complications or adverse effects during follow-up. The patients were discharged on the same day and treated according to standardised hospital protocols.

- Advantages:
  - Improved anatomical posterior stability.
  - Reduced risk of posterior tibial subluxation.

- Disadvantages:
  - Technically demanding procedure.
  - Potential of increased surgical time.

6. Outcomes of the novel technique

During surgery, there were no technical difficulties, and no changes were made to pharmacological or therapeutic regimens. Patients were discharged on the same day and treated according to standardised hospital protocols.

The patient is placed in a supine position. A lateral post is placed proximally on the thigh at the level of the tourniquet, and a footrest is used to maintain the knee in a flexed position of 70–80°. The inferomedial and inferolateral parapatellar working portals and a supramedial exit portal are created vertically. The inferolateral portal is placed slightly more laterally than in routine knee arthroscopy to improve visualisation of the medial femoral condyle during femoral tunnel drilling. The inferomedial portal is positioned on the medial aspect, adjacent to the medial border of the patellar tendon and proximal to the medial meniscus. Diagnostic arthroscopy is performed to address any meniscal pathology. Two additional posteromedial portals are created for visualisation and preparation of the tibial insertion of the PCL. The safety of the posteromedial portals and the benefit of using dual portals to assist in medial meniscus repair are well documented [8,9].

The posterior compartment of the knee is visualised, and a posteromedial portal is established using a guided passage or catheter number 18, and cannula implantation follows. The posterior capsule is carefully cleaned and released using a shaver and radiofrequency, considering the proximity of vascular structures.

The surgical procedure involves using a Clancy System to pass guides in an outside-in manner at two separate points of the PCL imprint on the femoral condyle. (see Fig. 1). Perforations are made based on the diameter of the graft, with a preferred width of 8 to 10 mm for each bundle. Two tunneling spots are also chosen in the posterior aspect of the tibia, 1–1.5 cm below the articular surface, for the double bundle (see Fig. 2). Two cerclage wires in the shape of eyelets are retrieved through the anterior portals for graft suture passage and tibial tunnel traction (see Fig. 3).

A graft, 25–30 cm long and 8–10 mm wide, is inserted into one of the femoral tunnels and subcutaneously passed through the second tunnel on the femur, leaving a U-shape union in the femoral area with no fixation (see Fig. 4).

Devitalized tissue is removed, and the graft tension is measured at knee flexion and extension, ensuring proper placement and tensioning.

Fig. 1. Passage of guides in the femoral condyle with a Clancy System in an out-in manner (A, B), with location and exit in the footprint of the PCL at its femoral insertion (C).
Fig. 2. Broaching and passage of guides through tunnels in the posterior area of the tibia 0.5 inches inferior to the articular surface with the use of a posterior guide (A). Arthroscopic view (B).

Fig. 3. Wires are retrieved through the anterior portals for the passage of graft sutures and traction through tibial tunnels (A, B, and C).
A posterior drawer test was performed on all 16 patients preoperatively, immediately after surgery, 3 weeks after surgery, and 6-months after surgery to assess posterior displacement of the tibia. Measurements were carried out by the same physicians to avoid technique variations. At 6-month follow-up, all 16 patients had minimal posterior displacement, no greater than 1–2 mm, averaging 10.6 mm preoperatively. To this date, we have followed up with patients for 1 to 3 years, and all have shown satisfactory results. No complications or adverse effects were recorded.

7. Conclusion and future perspectives

This novel surgical reconstruction technique aims to reconstruct the PCL closely to its normal anatomy by mimicking the anterolateral and posteromedial bundles, which significantly improves knee stability and kinematics. Further research is necessary to establish the double-bundle U-DOS Reverse Technique as the standard treatment for high-grade PCL tears.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jisako.2023.08.002.

References