TITLE: INTERCRUCIATE TRANS-SEPTAL ARTHROSCOPIC APPROACH TO THE POSTERIOR COMPARTMENT OF THE KNEE JOINT

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ABSTRACT

Approach to the posterior compartment of the knee joint and working within it has been made assessable since the trans-septal approach was established. Herein, the authors describe a simple intercruciate trans-septal approach to the posterior compartment of the knee joint. This technique allows a direct visualization to the posterior septum (septum), creating a safer trans-septal portal and easier separation of the septum. The authors have used this approach in conditions such as the posterior cruciate ligament (PCL) reconstruction, PCL avulsion repairs, Popliteus tendon reconstruction, posterior compartment synovectomy, hardware removal, loose bodies removal, RAMP lesion repair and others. No complications such as femoral condyle damage, meniscus damage or neurovascular bundle injuries has occurred with this approach.

<table>
<thead>
<tr>
<th>INTERCRUCIATE TRANS-SEPTAL APPROACH TO THE POSTERIOR COMPARTMENT OF THE KNEE JOINT</th>
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<tbody>
<tr>
<td>• Approaching the posterior septum through an intercruciate approach</td>
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<tr>
<td>• Between the septum adjacent to superomedial aspect of anterior cruciate ligament and superolateral aspect posterior cruciate ligament</td>
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<tr>
<td>• 2 apertures are created on the posterior septum – posterolateral and posteromedial.</td>
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<td>• These apertures will aid in creating the posteromedial and posterolateral portals</td>
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<td>• Via these two posterior portals, the posterior septum is separated and debrided</td>
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<td>• Once adequate space achieved in the posterior compartment of the knee joint, further planned procedures can be carried out e.g. PLCR, RAMP repair etc.</td>
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### ADVANTAGES

- Simple and safe
- No vital structures are located within intercruciate areas
- No obstructing structures
- Reduces risk of injuring surrounding structures e.g. femoral condyles, meniscus
- Direct posterior septum visualization
- Vision is not blinded while creating the apertures through the septum

### DISADVANTAGES

- In smaller size knee with narrow intercondylar width, working with this technique may find some difficulties as this may lead to overcrowding and movement limitation of the arthroscopic instruments

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**OUTLINE OF CLINICAL PROBLEM**

Arthroscopic surgery is evolving within the Orthopaedic fraternity especially among sports surgeons. In knee arthroscopy, anterior compartment is easier to maneuver if compared to posterior, due to its near proximities from the portals and has lesser barriers to overcome.

Few approaches to the posterior compartment were well described in the literatures e.g. intercondylar notch posterior compartment assessment\(^1\) or anterior and posterior triangulation via the trans-notch approach. However, structures such as cruciate ligaments, femoral condyles’ curvature, and tibial spine, limits the arthroscope and its instruments to maneuver around\(^2\). Lesions in posterior horn of medial meniscus might be missed, femoral condyles’ posterosuperior compartment exposure might be inadequate, limitations to certain components of the PCL with poorly visualized posterior meniscofemoral ligament, septum, and posterior capsule\(^3\).
CURRENT SURGICAL TECHNIQUE

Working around a divided posterior compartment of the knee joint arthroscopically, is difficult due to its limited space and surrounding obstructing structures. Several techniques have been described in literatures to battle these difficulties\textsuperscript{3,5,6}. Anterior and posterior triangulation via a trans-notch approach, but presents of osteophyte at the femoral condyle, prominent tibial spine, or small knee joint, limits the arthroscope in the intercondylar notch. Lewicky and Abeshaus described a simpler anteromedial -posteromedial and anterolateral – posterolateral triangulation by introducing the arthroscope through the patella tendon\textsuperscript{7}. Few disagrees as this may cause tendinitis.

Kim et al described a trans-septal technique in 1997, bridging the posterior compartments of the knee joint. This technique completely removed the arthroscope’s blind spot and provides an excellent field of the posterior compartment. Since then, many authors have described many innovative trans-septal techniques. Ahn et al\textsuperscript{5} described penetrating the septum from posteromedial to posterolateral trans-septal approach by using a rod and shaver. Ohishi et al\textsuperscript{3} described a posterolateral to posteromedial trans-septal approach using Kischner wire. All these methods, requires a mandatory trans-notch approach\textsuperscript{5}. Difficulties mentioned above might hinder the simplicity of this technique. Technique described only allows visualization at one side of the septum, while the other side is blinded.

NOVELTY OF THE NEW TECHNIQUE

Herein, the authors described their technique of trans-septal approach which is simple and safe. They perform their technique routinely in PCL reconstruction, Popliteus tendon reconstruction, PCL avulsion fixation, medial meniscus RAMP lesion repair, hardware removal such as screws, loose bodies removal and posterior compartment synovectomy.
Patients lies supine with affected knee joint flexed 90° on the table [Fig 1]. The unaffected limb is in lithotomy position. Patients is under spinal anesthesia. Tourniquet is inflated at 300 mmHg and arthropump is used at 40mmHg. Routine arthroscopic examination is performed via standard anterolateral and anteromedial portals using a 30° arthroscope. Both portals are 1 cm above the joint line, adjacent to lateral and medial border of the patella tendon [Fig 2]. Once routine examination is performed, approach to the posterior compartment is established by these following steps.

**Step 1** – Identifying the femoral insertions and borders of ACL and PCL [Fig 3]. Intercruciate area is bounded – laterally: medial border of ACL, medially: lateral border of PCL, superiorly: intercondylar notch and inferiorly: intersection between the medial border of ACL and lateral border of PCL [Fig 4].

**Step 2** – Soft tissue within the intercruciate area is removed using a motorized shaver (shaver) until the anterior border of the intercondylar fossa is visualized. The shaver’s tooth and probe are maintained in upwards direction and close to the bone to avoid injuring the cruciate ligaments. Shaver is then replaced by a radiofrequency ablation (probe) to cauterized soft tissues within the intercruciate area. Usage of probe is to obtain better soft tissue clearance off the bone for better bony visualization. Soft tissues are cauterized from 11 to 1 o’clock of the intercondylar fossa while advancing 1 cm posteriorly until the superior attachment of the posterior septum is identified. [Fig 5].

**Step 3** – Two apertures are created at the septum [Fig 6]. Firstly - posterolateral aperture, which is located between 4 and 5 o’clock (8 and 9 o’clock in right knee) of the septum. Shaver is used to shave of a small portion of the septum until it bridges into the posterolateral compartment of the knee joint. Second - posteromedial aperture, which is located between 8
and 9 o’clock (4 and 5 o’clock in right knee) of the septum. Similar manner is done for the
posteromedial aperture.

Step 4 - Arthroscope is advanced into posteromedial compartment looking towards the
posteromedial joint capsule. The capsule is palpated from the outside to locate a proper
posteromedial portal - the soft spot between medial collateral ligament, medial head of the
gastrocnemius muscle and semimembranosus tendon. Under direct visualization from inside
of the joint, a 18g spinal needle is inserted percutaneously from outside about 5 mm proximal
to the medial meniscus, into the posteromedial compartment until the tip of the needle is
seen. Transillumination technique is used to confirm the needle placement being away from
crossing veins in the posteromedial aspect of the knee joint. A longitudinal stab incision is
made alongside the needle by a No. 11 size blade into the knee joint until the tip of the blade
is seen penetrating the capsule. A straight hemostat is used to enlarge the stab wound. A
Wissinger rod (rod) is inserted into the posteromedial compartment via the posteromedial
portal. Arthroscope is now positioned viewing the anterior aspect of the intercondylar notch
and rod is guided into posterolateral compartment by passing through the posteromedial and
posterolateral apertures of the septum [Fig 7].

Step 5 –Skin is marked on the lateral aspect of the knee joint illustrating the lateral collateral
ligament (LCL), biceps femoris tendon (BFT) and head of fibula. Soft spot within these
borders is the landmark of the posterolateral portal [Fig 8]. Rod is then advanced laterally
until it resists against the posterolateral capsule. A protruded skin can be seen externally
within LCL, BFT and 2 cm proximal to the head of fibula. While maintaining the tension
against the capsule with the rod, blade No.11 is used to incise the skin until the tip it is
visualized. The rod is further advanced laterally. When the rod passes through these two
portals (posteromedial and posterolateral) and anterior to the septum via the two apertures, it
pushes to septum more posteriorly. Arthroscopy sheath is placed into the rod from lateral to medial and vice versa, to enlarge the posterior portals and windows of the septum.

**Step 6** – Once trans-septal portal is established, arthroscope is placed via posterolateral portal looking into the posteromedial aperture of the septum [Fig 9]. Shaver is inserted via the posteromedial portal. Maintaining the shaver’s tooth anteriorly, posteromedial septum’s lining is shaven off in a up and down manner. Caution not to shave of the superior insertion of the posterior septum to avoid injuring the middle geniculate vessels ³. Posterolateral septum’s lining is shaven off in similar manner. Probe is used for further soft tissue clearance. Further planned procedures may proceed the after septum is shaven off.

Special attention should be given to avoid injuring the middle geniculate artery (MGA). This artery originates from the popliteal artery, where it enters the proximal portion of the septum [Figure 10]. It distributes richer vasculature proximally compared to the distal portion of the septum. Therefore, it’s advisable to initiate from distal portion rather than the proximal portion to reduce MGA injury complications⁸ while creating trans-septal portal. Popliteal artery lies immediately behind the septum outside of the posterior capsule and with knee in 90⁰ flexion, the popliteal artery to fall more posteriorly providing greater distance from the PCL ³. This allows us to safely perforate the septum anteriorly when creating the apertures.

Few advantages of the authors’ technique [Fig 11]. Simple direct intercruciate approach with no obstructing obstacles and lesser risk of injuring surrounding structures. Safe as no vitals structures are located within the intercruciate area. No blind penetration of the septum. The rod is guided visually in passing through the septum from posteromedial to posterolateral compartment. The posterolateral portal blind penetration is considered safe as the exit point (soft spot) is between the LCL, BFT and fibula head, where no important structures are
located within it. However, be cautious not to injure the posterolateral capsule as the popliteal artery runs 10mm laterally to the septum. In cases where the rod is not protruded in the safe posterolateral soft spot, an outside-in posterolateral portal creation via the safe soft spot should be performed. Pitfall of this approach is seen in smaller knee joint with shorter intercondylar width. This may cause some difficulties in maneuvering the arthroscope or the instruments due tight space of the notch causing overcrowding.

OUTCOMES

The authors have performed this approach on 24 patients with pathologies in the posterior compartment of the knee joint [Fig 12] and have not encountered any complications such as vascular injuries (popliteal artery, MGA, saphenous veins) or nerve injuries (posterior tibial nerve, saphenous nerve). On follow ups with minimum of 6 months, no active complaints are seen, and patients were able to return to their daily activities after undergoing their scheduled rehabilitation program.

CONCLUSION

This technique of approaching the posterior compartment of the knee joint via an intercruciate trans-septal approach, for the pathologies in the posterior compartment of the knee joint is a safe and reliable technique.
REFERENCES


Fig 1 - Patient’s position in lateral [A] and anteroposterior [B] view. Affected limb is in a position with knee in 90 degrees flexion on the table. Unaffected limb is placed in a lithotomy position.

Fig 2 - Left knee joint. [A]: (1) Anterolateral portal skin marking, (2) Anteromedial portal skin marking. [B]: Routine arthroscopic examination via anterolateral and anteromedial portals.
Fig 3 - (1) Anterior Cruciate Ligament, (2) Posterior Cruciate Ligament, (3) Lateral Femoral Condyle, (4) Medial Wall of Lateral Femoral Condyle, (5) Medial Femoral Condyle, (6) Lateral Wall of Medial Femoral Condyle

Fig 4 - (1) Blue line: Lateral Border of PCL, (2) Green line: Medial Border of ACL, (3) Red line: Anterior border of intercondylar fossa, (4) Intercondylar fossa
Fig 5 - [A]: (1) Blue line: Lateral Border of PCL, (2) Green line: Medial Border of ACL, (3) Red line: Anterior border of intercondylar fossa, (4) Intercondylar area, [B] - (1) Posterior septum with a clear space anterior to it.

Fig 6 - [A] Posterolateral and Posteromedial apertures of the Posterior Septum. [B] Posteromedial aperture. [C] Posterolateral aperture
Fig 7 - Passing of Wissinger Rod from medial to lateral.
(A) Through the posteromedial aperture of the septum.
(B) Passing anterior to the septum.
(C) Passing into the posterolateral aperture of the septum
Fig 8 - Skin marking on the lateral aspect of left knee joint. (1) Lateral epicondyle. (2) Lateral collateral ligament (3) Head of fibula. (4) Biceps femurs tendon (5) Posterolateral portal landmark
Fig 9 - (A) view from posterolateral compartment into the posterolateral and posteromedial aperture of the posterior septum. (B) Similar view from posterolateral compartment after the septum is partially removed.
Fig 10 - Anatomical position of the Popliteal Artery and Middle Genicular Artery - PCL is omitted for better viewing (Aldridge et al8)
<table>
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<tr>
<th>TECHNIQUE ADVANTAGES</th>
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<td>Direct visualisation of the posterior septum of the knee joint</td>
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<tr>
<td>Safe. No vital structures within the intercruciate area.</td>
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<td>Easy. No obstacles or tight spaces to overcome in order to reach the posterior septum</td>
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<td>Allows direct visualisation of Wissinger rod passing Through the posterior septum</td>
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<td>No blunt penetration of the posterior septum.</td>
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<td>No blinded vision while working with the posterior septum</td>
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<tr>
<td>No injuries to the surrounding structures while manoeuvring the Arthroscope intro the posterior compartments. Eg. Femoral condyles, meniscus</td>
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*Fig 11 - Advantages of the Intercruciate Trans-septal approach to the posterior compartment of the knee joint.*
### Operative Procedures

<table>
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<tr>
<th>Procedure</th>
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<tr>
<td>Posterior Cruciate Ligament Reconstruction [13]</td>
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<td>Popliteus Tendon Reconstruction [2]</td>
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<tr>
<td>Medial Meniscus RAMP lesion repair [5]</td>
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<tr>
<td>Posterior compartment loose bodies removal [4]</td>
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<tr>
<td>Hardware removal eg: screw in post Posterior Cruciate Ligament avulsion fixation [1]</td>
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<tr>
<td>Posterior compartment synovectomy in Pigmented Villonodular Synovitis [2]</td>
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**Fig 12 - List & Numbers [ ] of procedures routinely done by the authors using the Intercruciate Trans-septal Approach**