

Mucoid Degeneration of Anterior Cruciate Ligament—A Systematic Approach for Debulking



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Abstract: Anterior cruciate ligament (ACL) mucoid degeneration is an underdiagnosed condition that occurs when mucinous material develops in the ACL in the absence of synovial lining. Several authors have diagnosed this condition, discussed their own personal observations, and put forward their own suggestions for management. When diagnosed, one important strategy for management entails “debulking” the ACL using an arthroscopic debridement. No protocol has been described on the sequence of steps for ACL debridement during arthroscopy. We present our own in this Technical Note, with the addition of video footage that describes our arthroscopic technique for ACL mucoid degeneration debridement using radiofrequency ablation and the sequence of steps. This Technical Note aims to demonstrate the procedure needed for arthroscopic debulking of a mucoid ACL, which will lessen ACL impingement while maintaining a stable knee.

A highly rare lesion known as mucoid degeneration of the anterior cruciate ligament (MDACL) was first noticed by Kumar et al.¹ in 1999. Although the exact cause of MDACL is unknown, there are many theories. MDACL may have a traumatic or degenerative etiology. According to the trauma theory, ACL strain results in the deposition of glycosaminoglycans.² The “synovial theory” describes how a synovium pouch herniates into ACL and then becomes filled with synovium.³ Synovial cysts of the anterior cruciate ligament (ACL) are different from MDACL because the latter does not form a cyst; on the contrary, mucoid tissue intertwines with ACL fibers.³ Magnetic resonance imaging (MRI) has revealed the prevalence of MDACL to be 1.8% to 5.3%.^{4,5} However, most patients with MDACL have no symptoms. Chronic posterior

knee discomfort and restricted terminal knee flexion or extension are frequent symptoms of patients with symptomatic MDACL.^{3,6}

However, we observed that there is history of trauma, either trivial or in the remote past. On clinical examination, there is decreased extension with pain on hyperextension (impingement on the roof) and pain in deep flexion (impingement on posterior cruciate ligament [PCL]). The anterior drawer, Lachman, and pivot shift tests are all negative indicators of stability. Age-related MDACL should be suspected in people with stable knees and chronic posterior knee discomfort. MDACL is identified by MRI scanning, on which it exhibits the characteristic celery stalk sign (Fig 1) and can be established by tissue sampling and histologic investigation.⁷ ACL synovial lining loss, continuous ACL fibers, increased ACL volume, palpable yellowish material, and increased ACL volume are the 5 arthroscopic diagnostic criteria.⁷ According to histology, connective tissue has a mucoid material that contains mucoproteins and glycoproteins.⁸

MDACL is typically treated nonsurgically, first with anti-inflammatory medications and physical therapy. ACL arthroscopic debridement, partial or complete resection, and occasionally ACL repair comprise surgical treatment. However, the method of debulking the mucoid ACL is not well documented in the literature. Here, we present a systematic approach to debulk the ACL.

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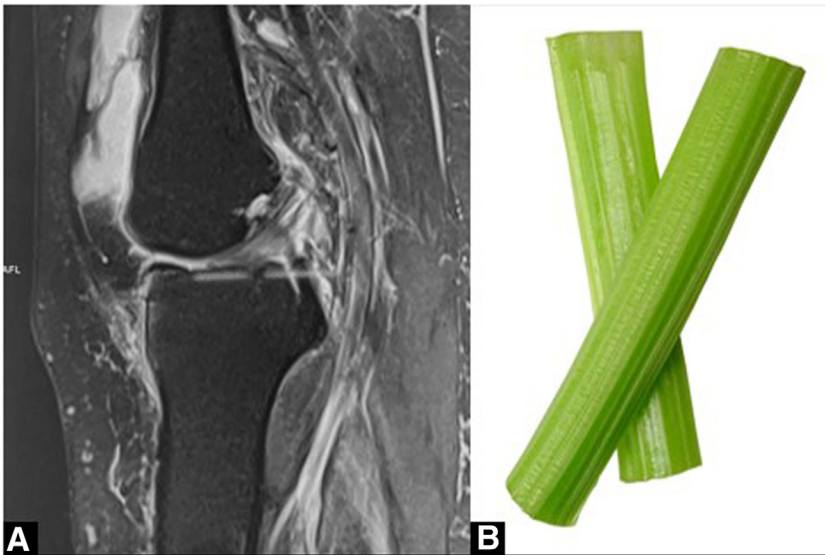


Fig 1. (A) MRI of the left knee. The sagittal T2-weighted PDFS image shows bulky ACL showing celery stalk appearance suggestive of ACL mucoid degeneration. (B) Pictorial representation of the celery stalk. (ACL, anterior cruciate ligament; PDFS, proton density fat saturated.)

Surgical Technique

Patient Preparation

The patient is transported to the operating room after their consent is obtained. The patient is positioned on the table with the knee flexed at 90°, side supports, and a footrest (sandbag). On the thigh, a tourniquet is applied and positioned as closely as feasible. When necessary, the tourniquet is inflated to a maximum of 350 mm Hg. [Figure 2](#) shows how to assemble and drape the knee for diagnostic arthroscopy as routine in our center. Examination under anesthesia is performed to assess the ACL's stability. Synovial fluid is aspirated and sent for analysis. In our patients, the intraoperative synovial fluid reports were normal (<200 WBCs/mm³, <25% neutrophils, and negative for organisms). With the knee in 90° of

flexion, standard anteromedial and anterolateral portals are made with a number 11 blade in the standard places, medial and lateral to the patella tendon.

Surgical Steps

The steps of the procedure are shown in [Video 1](#) and discussed in the following text.

1. Diagnostic arthroscopy: The standard protocol is followed for diagnostic arthroscopy. The knee is examined for indications of meniscal disease or chondral injury. When the ACL is examined, it will be swollen, yellowish, and massive, completely occupying the femoral notch ([Fig 3](#)).
2. Debulking starts first at the proximal insertion of the ACL. It is probed and inspected for the presence of ganglion cysts. Then, we debulk in between the



Fig 2. (A-B) Positioning of the patient and operating room setup for left knee arthroscopy with left knee flexed to 90°.

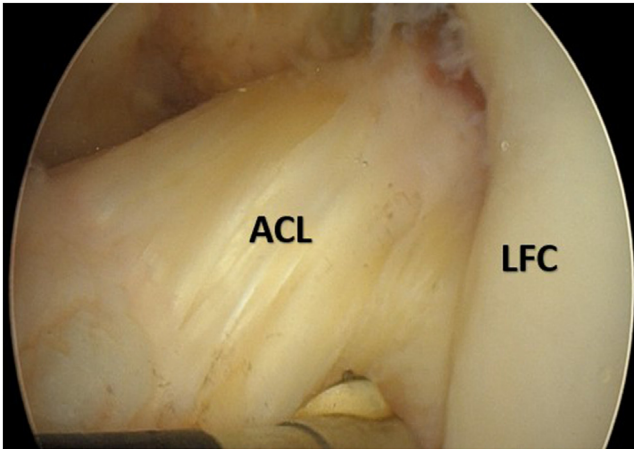


Fig 3. Arthroscopic view of left knee from the anterolateral (AL) portal showing bulky ACL covering the entire notch. (ACL, anterior cruciate ligament; LFC, lateral femoral condyle.)

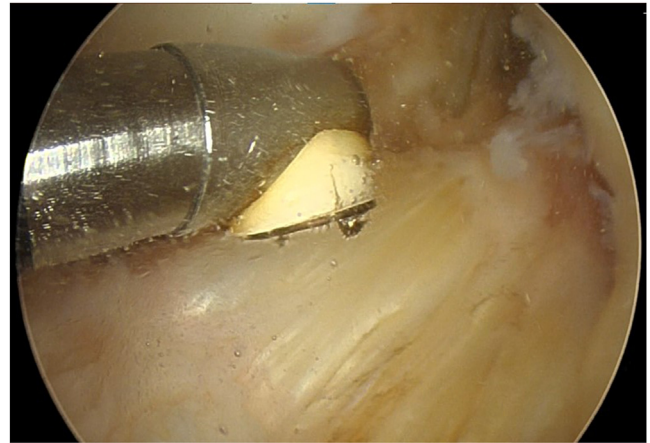


Fig 4. Arthroscopic image of the left knee, viewing from the anterolateral portal, showing debulking of the anteromedial bundle using a radiofrequency probe from the anteromedial portal.

ACL fibers using an arthroscopic shaver in low-power mode without the use of suction. During this procedure, we look out for any mucinous material that is expressed, which is then sent for investigation.

3. Using the anteromedial portal, the radiofrequency ablation probe (ArthroCare; Smith & Nephew, London, United Kingdom) is used, and we start with debulking of the anteromedial bundle near the medial wall of the lateral femoral condyle (Fig 4). The concept is to debulk enough tissue to avoid impingement.
4. Next, we release the adhesions between the ACL and the PCL with a radiofrequency ablation probe in coagulation mode.
5. We then proceed to recreate Howell's triangle (Fig 5B) and clear the notch with an arthroscopic

shaver in lower-power mode (Fig 6). Care is taken not to breach the septum. If osteophytes or a narrow notch is present, a high-speed round burr can be used to do a notchplasty.

6. The position of the knee is next changed from 90° flexion to a figure-of-4 position, and the posterolateral (PL) bundle is seen once the scope is advanced in the lateral compartment. If the PL bundle is found to be thickened and bulky, we then proceed to debulk the PL bundle (Fig 7) until the posterior horn of the lateral meniscus and lateral tibial spine are clearly visible.
7. When the PCL and the femoral notch are no longer impinged upon, flexion and extension tests should be done to evaluate the effectiveness of the ACL "debulking" at regular intervals throughout the debridement (Fig 8). In addition, ACL can also be

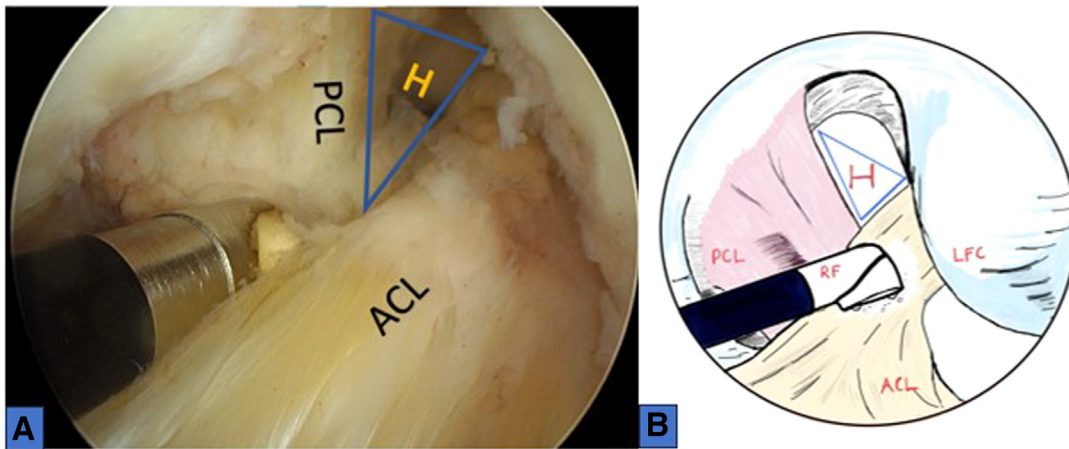


Fig 5. (A) Arthroscopic image of the left knee, viewing from the anterolateral (AL) portal, showing clearance of the notch and recreating the normal Howell's triangle. (B) Pictorial representation of recreating Howell's triangle. (ACL, anterior cruciate ligament; H, Howell's triangle; PCL, posterior cruciate ligament.)

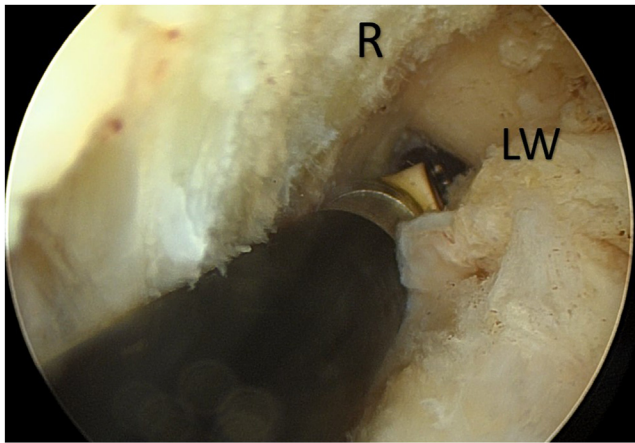


Fig 6. Arthroscopic image of the left knee, viewing from the anterolateral portal, showing clearance of the roof (R) and lateral wall (LW) of the intercondylar notch using a radio-frequency probe from the anteromedial portal.

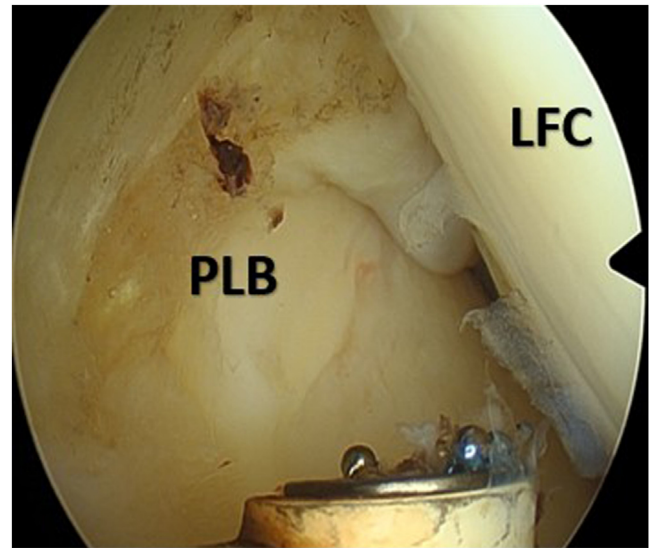


Fig 7. The arthroscopic image shows the left knee in figure-of-4 position, viewing from the anterolateral portal, with bulky PLB being decompressed. (LFC, lateral femoral condyle; PLB, posterolateral bundle.)

approached from the PL or posteromedial portals to debulk the enlarged ACL in those compartments. [Figure 9](#) depicts the sequence of key steps in debulking of mucoid ACL.

8. Any associated non-ACL pathology like meniscus or cartilage defect is then addressed.
9. After debulking the ACL, we perform microfracture using an awl ([Fig 10](#)) near the medial wall of the lateral femoral condyle to promote healing.
10. The Lachman and anterior and posterior drawer tests are used to assess knee stability after debulking. At the time of this operation, a reconstruction may be done if the ACL is determined to be unstable. The debulked ACL is now examined for PCL

and femoral notch impingement. Knee portals are closed in the usual manner, with sterile dressing and compressive bandage applied.

Postoperative Recovery

With sufficient analgesia, patient is made to weight bear as tolerated in the immediate postoperative period. Walking with crutches and gradual knee range of motion exercises are allowed from day 1. Patient assessed for wound status, alleviation of symptoms, knee stability, and range of motion at 14 days, 6 weeks, and 6 months after surgery.

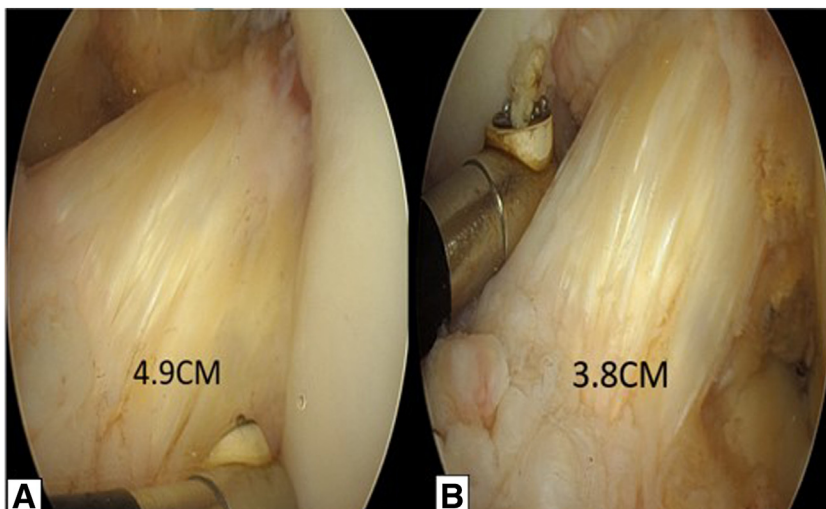


Fig 8. Arthroscopic image, viewing from the anterolateral portal, showing the anterior cruciate ligament (A) before (4.9 cm) and (B) after debulking (3.8 cm).

Fig 9. Addressing the concomitant knee lesions: (A) in the left knee, viewing from the anterolateral portal, a posterior horn medial meniscus tear was found and was addressed with an all-inside repair (FAST-FIX; Smith & Nephew, Andover, MA) and (B) microfracture to improve healing.

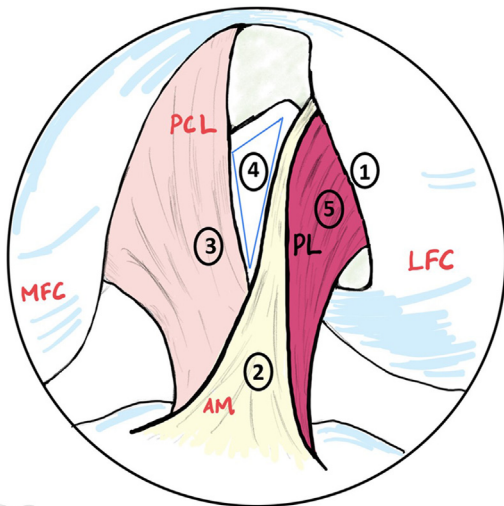
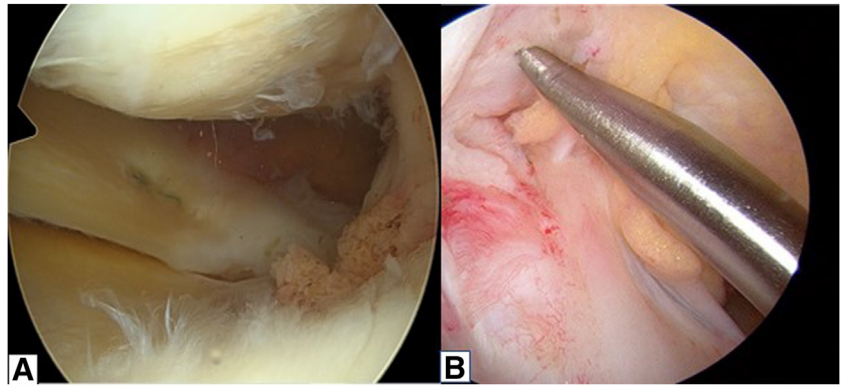


Fig 10. Pictorial representation of sequence of steps. 1: Proximal insertion of the ACL on the femur. 2: AM bundle of the ACL. 3: Between ACL and PCL. 4: Howell's triangle. 5: PL bundle of the ACL. (ACL, anterior cruciate ligament; AM, anteromedial bundle; LFC, lateral femoral condyle; MFC, medial femoral condyle; PCL, posterior cruciate ligament; PL, posterolateral.)

Table 1. Key Points for Debulking the ACL

- Make standard portals, perform diagnostic arthroscopy, measure the size of the ACL, and look for signs of impingement.
- Debulking of the AM bundle near the medial wall of the lateral femoral condyle (Fig 4).
- Release adhesions between the ACL and the PCL.
- Recreate Howell's triangle (Fig 5).
- Care should be taken to not breach the septum.
- Clear the notch with an arthroscopic shaver (in lower power mode) (Fig 6)
- Debulk the PL bundle in a figure-of-4 position (Fig 7).
- Evaluate the effectiveness of the ACL “debulking” with flexion and extension until there is no more impingement against the PCL and within the femoral notch (Fig 8).
- Any associated non-ACL pathology like meniscus or cartilage defect is then addressed (Fig 10A).
- After debulking, microfracture is done at the medial wall of the lateral femoral condyle to stimulate marrow stem cells (Fig 10B).

ACL, anterior cruciate ligament; AM, anteromedial; PCL, posterior cruciate ligament; PL, posterolateral bundle.

Table 2. Pearls and Pitfalls of the Procedure

Pearls	
➤	A large ACL can be gradually debulked with a conventional shaver in low power mode by beginning on the edges and heading toward the center. Radiofrequency ablation with additional benefit of coagulation on the ACL; is similarly effective for appropriate resection of synovium.
➤	A notchplasty with a burr may also be carried out if osteophytes or a narrow notch is present.
➤	Passive extension during surgery is frequently required to verify sufficient debulking and impingement-free mobility between the ACL and the notch.
➤	Debride the space between the ACL and PCL.
➤	A biopsy of the mucinous substance and the degenerating ligament to confirm the diagnosis.
➤	Debulk the posterolateral compartment until the lateral compartment is clear.
Pitfalls	
➤	Residual instability (in case of aggressive debulking of ACL)
➤	Incomplete notch resection
➤	Residual pain

ACL, anterior cruciate ligament.

Discussion

Mucoid degeneration of ACL is a largely under-diagnosed condition of the knee with subtle clues to the diagnosis on clinical examination. Chronic posterior knee pain in the middle and old age population should raise suspicion regarding the diagnosis of mucoid degeneration of ACL. Meniscal tears, chondral injury, and intraosseous cysts at the femoral and tibial insertion are frequently associated with mucoid degeneration.⁷⁻¹⁰ Although the appearance on MRI of mucoid ACL is highly characteristic, it is not uncommon to mistake it for a partial or complete tear.¹¹

Kumar et al.¹ suggested it is safe to remove the whole of pathologic ACL to achieve better clinical results and it did not lead to instability. Although arthroscopic complete or partial resection of mucoid ACL results in a good clinical outcome without a clinically significant instability, young patients should

be warned about the risk of instability and need of ACL reconstruction in future.^{9,10} Judicious debridement of muroid ACL and the mucinous material, preserving the intact fibers of the ACL to restore the normal anatomy, along with treating concurrent chondral and meniscal pathologies leads to good clinical outcome and early return to sports with low risk of instability.^{8,10-12} Additional notchplasty is required, especially in older age groups and people with a stenotic notch.^{3,13} The key to successful outcomes in debulking the muroid ACL is a sequential systematic approach, as elucidated in [Table 1](#) and [Video 1](#). Residual pain and instability can lead to poor outcomes if debulking is aggressive [Table 2](#).

Our technique describes the systematic approach to decompress muroid degeneration of ACL, which ensures adequate debridement of ACL in all the compartments, thus reducing the likelihood of postoperative pain and instability. With or without notchplasty, prudent debulking and decompression of the ACL in our patients has produced outstanding results in terms of an immediate reduction in postoperative discomfort and improved functional range of motion.

Disclosures

All authors (S.K.C., H.K., M.M.N., A.P., P.A.P., R.K., C.G., and R.S.A.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

1. Kumar A, Bickerstaff DR, Grimwood JS, Suvarna SK. Muroid cystic degeneration of the cruciate ligament. *J Bone Joint Surg Br* 1999;81-B:304-305.
2. Rolf C, Watson TP. Case report: Intra-tendinous ganglion of the anterior cruciate ligament in a young footballer. *J Orthop Surg Res* 2006;1:11.
3. Lintz F, Pujol N, Dejour D, Boisrenoult P, Beaufile P. Anterior cruciate ligament muroid degeneration: Selecting the best treatment option. *Orthop Traumatol Surg Res* 2010;96:400-406.
4. Bergin D, Morrison WB, Carrino JA, Nallamshetty SN, Bartolozzi AR. Anterior cruciate ligament ganglia and muroid degeneration: Coexistence and clinical correlation. *AJR Am J Roentgenol* 2004;182:1283-1287.
5. Salvati F, Rossi F, Limbucci N, et al. Muroid metaplastic-degeneration of anterior cruciate ligament. *J Sports Med Phys Fitness* 2008;48:483-487.
6. Cha JR, Lee CC, Cho SD, Youm YS, Jung KH. Symptomatic muroid degeneration of the anterior cruciate ligament. *Knee Surg Sports Traumatol Arthrosc* 2013;21:658-663.
7. McIntyre J, Moelleken S, Tirman P. Muroid degeneration of the anterior cruciate ligament mistaken for ligamentous tears. *Skelet Radiol* 2001;30:312-315.
8. Narvekar A, Gajjar S. Muroid degeneration of the anterior cruciate ligament. *Arthroscopy* 2004;20:141-146.
9. Sweed T, Mussa M, El-Bakoury A, et al. Management of muroid degeneration of the anterior cruciate ligament: A systematic review. *Knee Surg Relat Res* 2021;33:26.
10. Ventura D, Nuñez JH, Joshi-Jubert N, Castellet E, Minguell J. Outcome of arthroscopic treatment of muroid degeneration of the anterior cruciate ligament. *Clin Orthop Surg* 2018;10:307-314.
11. Pandey V, Suman C, Sharma S, Rao SP, Kiran Acharya K, Sambaji C. Muroid degeneration of the anterior cruciate ligament: Management and outcome. *Indian J Orthop* 2014;48:197-202.
12. Rajani AM, Shah UA, Mittal ARS, et al. Role of debulking muroid ACL in unicompartmental knee arthroplasty: A prospective multicentric study. *Knee Surg Relat Res* 2022;34:40.
13. Motmans R, Verheyden F. Muroid degeneration of the anterior cruciate ligament. *Knee Surg Sports Traumatol Arthrosc* 2009;17:737-740.