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Original Research Paper

Orthopaedics

"FUNCTIONAL OUTCOME OF COMBINED ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION WITH MODIFIED LEMAIRE EXTRA-ARTICULAR TENODESIS IN ANTEROLATERAL ROTATORY INSTABILITY"

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ABSTRACT

Aims and objectives: To compare preoperative and postoperative anterolateral rotation using Tegner Lysholm knee score, pivot shift,and IKDC score. To evaluate the outcome of arthroscopic anterior cruciate ligament reconstruction surgery **Materials and methods:** A total of 41 patients who underwent ACL reconstruction with Modified Lemaire Extra-articular Tenodesis with a minimum of 6 months follow-up evaluation were included in the study. Patients were examined prior to surgery, 2 weeks, 3 months, and 6 months. Post-operative parameters were assessed. Functional outcome using Tegner Lysholm knee score calculated, IKDC subjective knee scores were used to assess functional outcome. Rotational instability was also assessed clinically by positive pivotshift at 2 weeks,3 months, and 6 months. **Results:** Male predominance was observed and mean age of presentation was 31.27 years with sports injury being the important cause. Most of the patients were considered high-risk knees due to increased pre-operative pivoting activity and had Grade 2 Pivot Shift preoperatively Tegner Lysholm grade for the casesincluded in the study had poor grade, after Modified Lemaire LET, Pivot shift was negative in all but 1 post-operative cases, and IKDC score improved significantly along with Tegner Lysholm score Postoperatively. Graft re-rupture was a complication that arose in1 patient (2.4% of study population). **Interpretation And Conclusion**: ACL reconstruction along with Lateral Extra-articular Tenodesis using Modified Lemaire's Technique was beneficial in reducing Anterolateral Instability that arose from primary knee Injury in patients with high-risk knees and Improving daily activity and quality of life of postoperative patients which led to early return to sporting activities

KEYWORDS :

INTRODUCTION:

The knee joint is one of the most prevalent joint injuries in the body as a result of an increase in traffic accidents and increased participation in sports by the general public.The anterior cruciate ligament is the most frequently damaged ligament in the knee [1].

Disruption of anterior cruciate ligament alters the ability to maintain stability during rotational, accelerative, and decelerative actions, resulting in knee instability, mechanical failure, and loss of sensation [2].Its restoration helps athletes to return to their pre-injury levels and restores joint stability.

Previously, extra-articular surgeries and intra-articular reconstructions by open arthrotomy were performed, but[3] reduction in post-operative inflammation and the potential of early range of motion make arthroscopic reconstruction superior and more desirable to open methods.

Positive pivot-shift tests and prolonged rotatory laxity have been associated with poor clinical results, graft failure, and the need for revision surgery.[4]

Cadaveric studies have demonstrated that, when combined with ACLR, lateral extra-articular tenodesis (LET) is a good surgical approach for controlling anterolateral rotatory laxity of the knee caused by injury or ALC insufficiency.[5]

With the introduction of intra-articular repair, particularly arthroscopic procedures, LET fell out of favor. [6]

However, a number of more recent systematic reviews and meta-analyses have clearly showed that adding LET to an intra-articular ACLR improved rotatory laxity as measured by pivot shift.

The primary hypothesis of the present study was that ACL reconstruction associated with modified Lemaire extra-articular lateral tenodesis will show good results in laxity control, and reduce rotatory instability thereby contributing to improvement in the functional outcomes at 6-month minimum follow-up.

MATERIALS AND METHODS :

The present Prospective cohort study was conducted on patients of either gender with ACL tear undergoing ACL reconstruction with ALL reconstruction using Modified Lemaire's Lateral Extra-articular Tenodesis in the Department of Orthopedics, Vydehi Institute of Medical Sciences and Research Centre, Bangalore.

Sample size: Sample size is calculated based on Wang X et al. study using formula.

$N = [Z_{1-\alpha/2} \times p(1-p)/d2$

$Z^{1-\alpha/2} = 1.96$ at 95% confidence level

P=0.88; d= 0.1; Total sample size = 41

Inclusion Criteria: Age Group 15-55, High-Risk Knee (Female patients, football players, ligament laxity) , High-Grade Pivot Shift, Failed, Well Performed ACL reconstruction, Revision ACLR, Increased Posterior Tibial Slope, Meniscal Deficient knees, Patients who want to return to high pivoting activity,

Presence of Segond's fracture or identified ALL injury.

Exclusion criteria: Active articular infection, Inflammatory joint disease, Generalized Ligamentous Laxity

Methodology: All patients fulfilling the inclusion and exclusion criteria were included in the study after obtaining their consent. A common protocol of history taking, clinical examination, routine blood investigations, and preoperative x-ray imaging and MRI (Magnetic Resonance Imaging) were performed Preoperative Tegner Lysholm and IKDC scores were recorded for all patients. Grading of Pivot Shift was done

Preoperative Rehabilitation

Preoperative strength and range of movement of knee joint were measured and documented.

Static and dynamic quadriceps exercises were taught to patients while awaiting surgery.

All patients were enlightened on postoperative rehabilitation.

Patients and their attenders were well explained about the advantages and disadvantages of procedure. Risk-benefit ratio was explained.

Operative Technique

All the patients in our study were operated under spinal anesthesia in supine position. The following tests were done under anesthesia – anterior drawer test, posterior drawer test, Lachman test, and pivot shift test.A pneumatic tourniquet is applied which is positioned in the upper thigh after soft padding. The limb is scrubbed from the ankle up to the tourniquet.In all the cases, prophylactic antibiotic usually 1 g Cefoperazone and 500mg sulbactam was given preoperatively before inflation of the tourniquet. The limb is held upright to exsanguinate the limb before inflation of the tourniquet.

Surgical Technique

The technique of single-bundle ACL reconstruction was done with one tibial tunnel and one femoral tunnel with their centres corresponding to the footprint of the native ACL tibial and femoral attachment sites respectively. The femoral tunnel was made using the anteromedial portal thereby creating an anatomicfemoral tunnel position. The graft was fixed at the tibial side using interference screw and at the femoral side using interference screw/endobutton.

Diagnostic Arthroscopy

Before the harvesting ofgraft,diagnostic arthroscopy was donefirst and all the pathologies have been recorded, the anteromedial (working) portal is then established. The associated pathologies are dealt accordingly such as partial/total meniscectomy for meniscal tears and loose body removal.

Hamstring Graft Harvest And Graft Preparation

A 3cm oblique skin incision is made starting 5 cm below the medial joint line and 1 cm medial to the tibial tuberosity. The oblique incision is preferred. It is planned to do the graft harvest and tibial tunnel drilling through the same incision.

The superior border of the pes anserinus is identified using the fingers. This superior border is lifted, and fascia incised. The tendons can be felt with fingers running from above downwards. The lowest one felt is the semitendinosus tendon.

After the hamstring tendons are identified, the sartorius fascia is divided along the course of the tendons (gracilis and semitendinosus), taking care to preserve the deep layer containing the medial collateral ligament. With the help of right-angled artery forceps, the gracilis and then the semitendinosus is hooked out. The tendon ends were tied with double loop knot to aid in traction.

The knee is placed in 90 degrees of flexion and proximal dissection of the tendons were done using blunt dissection by fingers till the musculotendinous junction. The main band which connects the medial head of gastrocnemius is usually cut with the help of scissors.

It is confirmed that as the tendon is pulled distally, there should be no dimpling posteriorly over the gastrocnemius. The distal end of the tendon is freed with the scissors. Then a tendon stripper is advanced over the tendon in line with it maintaining firm, steady and gentle pressure and at the same time applying traction by holding the threads. The gracilis is usually more muscular appearing than the semitendinosus.

The harvested graft is then placed on Graft master board. The tendons are removed of any residual muscle fibers with the help of blunt end of the blade.

Fig 1 **Fig 2**

Fig1: Skin incision, pes anserinus identified and fascia incised for graft harvest; Fig2: Identified Gracilis and semitendinosus tendon

The tendon ends are trimmed to achieve uniform size. A whipstitch is placed at both ends of the tendons. Around 3-4 cm of both the ends of the tendon were stitched together. The two tendons are looped over an umbilical tape. The composite graft is then passed through the graft sizer. The diameter of the tunnel to be made is equal to the smallest sizing sleeve through which the quadrupled graft passed with minimum friction.

The graft length to be placed inside the femoral tunnel is marked to ensure correct placement of graft within the femoral tunnel while being viewed arthroscopically.The loop of the four-strand graft is tied to the posts in the graft master board and pre-tensioning is done by applying a pressure of about 15 pounds for around fifteen minutes.

Figure 3: Harvested grafts- Gracilis and semitendinosus tendon

Figure 4: Prepared Gracilis and semitendinosus tendon Quadrupled graft

Intra-articular preparation

The arthroscope was introduced via the anterolateral portal and joint cavity visualised. The shaver blade is inserted through the anteromedial portal and the joint is debrided of ligamentum plicae, fat pads and synovial reflections that hinder a thorough inspection of the tibial footprint of the ACL and medial surface of the lateral femoral condyle. During the joint debridement, care should be taken to avoid injury to the intact PCL.

Notch preparation and Notchplasty

Then the visualisation of the intercondylar notch is done. The residual ACL tissues are removed

The careful shaping and enlargement of the intercondylar notch of the femur is called notchplasty. The notch is usually deepened by 2-3 mm starting anteriorly on the articular surface of the intercondylar notch, superior to the margin. The direction of deepening of the notch should be anterolateral. The anteromedial side of the notch is not deepened unless there is presence of osteophytes.

Figure 5: Notchplasty

Femoral tunnel preparation

The ACL footprint is visualised on the medial surface of the lateral femoral condyle in 90 degrees of knee flexion and the entry point is marked. Then with the femoral offset aimer device inserted through the anteromedial port, the entry point is drilled with a guide wire in 120 degrees of knee flexion. The drilling is continued till the tip of the guide wire emerges on the lateral side of the distal thigh at the level of epicondyle of femur.

Then using the 4.5 mm cannulated drill bit, the femoral tunnel was made by drilling both the near and far cortices. Then the length of the tunnel was measured using a depth gauge. Then the femoral tunnel was reamed with a reamer corresponding to the diameter of the graft. The reaming was stopped 15-20 mm from the lateral cortex depending on the length of the graft. After the femoral tunnel is made, the beath pin with ethibond at its end was passed via the femoral tunnel to aid in easy passage of prepared graft.

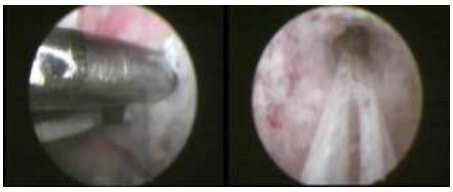


Figure 6: Femoral aimer at site of ACL footprint;
Figure 7: Femoral tunnel after reaming

Tibial tunnel preparation

The tibial tunnel is made with the help of the tibial guide. With the knee in 70-90 degrees of knee flexion, the tip of the tibial guide is placed 2-3mm anterior to the (posterior margin of) anterior horn of lateral meniscus and slightly medial to the midline of the ACL tibial attachment area. Then the tibial tunnel is made by reaming over the guide pin using cannulated drill bit with diameter equal to the diameter of the graft. The edges of the tunnel are smoothened using shaver s at the site of ACL tibial attachment site for better proprioception.

Graft preparation, passage and fixation

After the graft had been prepared, based on the length, the graft is quadrupled, the loop part of the quadrupled graft is attached to the endobutton with loop, in patients with endobutton with interference screw,the length of the loop in the endobutton depends on the graft length and the length of the

Figure 8: Tibial aimer device

unreamed femoral tunnel. The Ethibond suture already present within the joint is pulled out through tibial tunnel. Then the passing sutures for the ACL graft are passed through the suture loop and are taken out of the lateral thigh. With the help of these sutures, the graft is pulled via the tibial tunnel into the joint and then into the femoral tunnel . Once the estimated length of the graft is within the tunnel, the Endo button is flipped.

Then cyclical tensioning of the graft is done by repeated knee flexion and extension (around 20-30 times) with sustained pull on the graft via the tibial tunnel. Then the arthroscopic visualization of the graft is done to look for any signs of graft impingement, alignment, etc. The tibial side of the graft is fixed with interference screw of appropriate length. The ports and the graft harvest site wound are closed in layers. Sterile compressive dressing is then applied. The limb is immobilized with the use of knee brace.

Figure 9: Graft fixation using (a) interference screw(b) endobutton on femoral side

Figure 10: Graft fixation using interference screw on tibial side

Following the completion of ACL Reconstruction, Modified Lemaire extra-articular tenodesis is performed as follows A 6-cm skin incision is placed just posterior to the lateral epicondyle. The subcutaneous tissue is dissected down to the iliotibial band(ITB). A 1-cm-wide by 8-cm-long strip of the posterior half of the ITB is fashioned, leaving the distal attachment at Gerdy's tubercle intact.

The free end is whipstitched with number-1 Vicryl suture, tunnelled deep to the fibular collateral ligament (FCL), and attached to the metaphyseal flare of the lateral femoral condyle at the insertion of the distal Kaplan fibres of the ITB. Fixation is performed with a staple, with the graft tensioned to no more than 20 N (bysimply holding it taut and not "tensioned"), with the knee held at 60° of flexion and neutral rotation of the tibia.

Figure 11- Incision for LET with ITB and Femoral Tunnel for ALL reconstruction;
Figure 12 Fixation of ITB with Bioabsorbable Interference Screw

Postoperative management
Immobilization in knee brace and limb elevation was done in the immediate post-op period. Intravenous antibiotics were given postoperatively for 3 days. Wound was inspected on 2nd, 8th postoperative day. The sutures were removed on 12th postoperative day. Rehabilitation was started from day one.

ACL Rehabilitation protocol Stage I: 0 to 2 weeks. Patella mobilization, Motion control braces 0 to 90 degrees evaluation, Quadriceps sets/straight leg raising in all planes (emphasize SLR without extension lag), Prone/standing hamstring curls, Passive extension (emphasize full extension), Prone hangs, Pillow under heel, Passive, active and active assisted ROM knee flexion, Wall slide, Sitting slide, Partial weight-bearing 50 to 75% with crutches or weight-bearing to tolerance without crutches if motion control brace locked in full extension, Sleep in brace locked in full extension

Goals
Full knee extension, 90-degree knee flexion, good quadriceps strength, emphasize normal gait.

Stage II: 2 to 4 weeks
Motion control brace – full range of motion., Progress ROM to 120 degree by fourth week, Progress SLR and prone / standing hamstring curls with weights, Full weight-bearing with crutches and discontinue crutches when ambulating without limp.

Wall sits at 45 degrees angle with tibia vertical, progress time, Knee extension 90 to 60 degrees with manual resistance by therapist.

Goals
Range of motion – 0 to 120 degrees, Full weight bearing with crutches and no limp.

Stage II: 4 to 10 weeks
Progress to full ROM by 6 weeks, Begin lunges, Continue strengthening of lower extremity muscle groups, especially through full range of hamstring/ quadriceps.

Stage III: 12 to 16 weeks
Continue flexibility exercises, Quadriceps strength progression, Sports specific cardiovascular fitness.

Stage IV: 16 to 18 weeks
Begin plyometric program with shuttle, minitrampoline if quadriceps strength 65%, no effusion, full range of motion, stable knee, Begin jogging program if quadriceps strength 65%.

Stage V: 5 to 6 months
Sports-specific drills, Agility training.

Stage VI: 6 months return to sport if
Motion >130 degrees, Hamstring > 90 %, Quadriceps > 85%, Sports specific agility training completed.

Evaluation
All patients were subjected to post-operative antero-posterior and lateral radiographs to determine the tunnel placement and position of interference screw/ endobutton and interference screw of tibia.

Patients were followed at 2 weeks, 3 months and 6 months and their functional outcomes were assessed.

Intraoperative (tourniquet time, graft rupture) and post-operative (persistent anterior knee pain, persistent effusion, infection, DVT/PE) parameters were assessed.

Their clinical outcome was assessed using Lachman test, and pivot shift test, and functional outcome using Tegner Lysholm knee score and IKDC Scores, Tegner Lysholm knee score was calculated for: 1.limp 2.support 3.locking 4.instability 5.pain 6.swelling 7.climbing stairs 8.squatting and grading will be done as poor, fair, good or excellent based on total score.

Statistical analysis:
Data was entered into Microsoft excel data sheet and was analyzed using SPSS 22 version software.

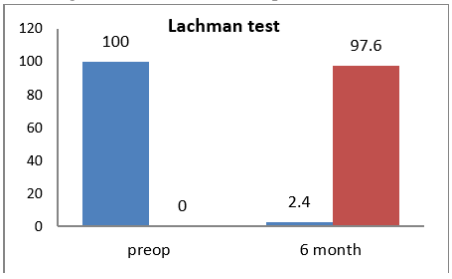
RESULTS:
In the present study, Mean age of subjects was 31.27 ± 8.423 years of which majority of subjects were 21 to 30 years (46.3%).

In the present study 95.1% were males and 4.9% were females. Mechanism of injury was sports in 53.65%, RTA in 24.39% and slip and fall in 21.95.%.

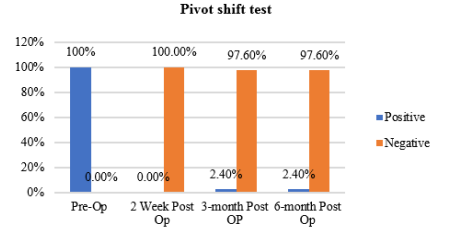
Mean time of injury to surgery was 4.07 ± 1.967 months. In the present study most common side of injury was right side (61%), followed by left side (39%).

Anterior drawer test at pre-op, 100% were positive. At 6 months, 97.6% were negative and 2.4% were positive.

Lachman test at pre-op, 100% were positive. At 6 months, 97.6% were negative and 2.4% were positive.



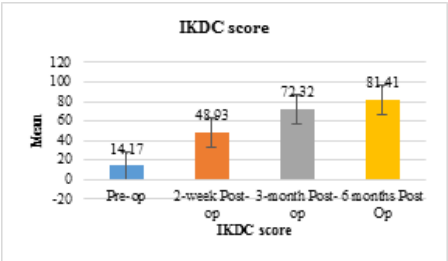
Pivot shift test, at Pre-op 100% were positive. At, 3 months and 6 months, 2.4% were positive and 97.6% were negative respectively.



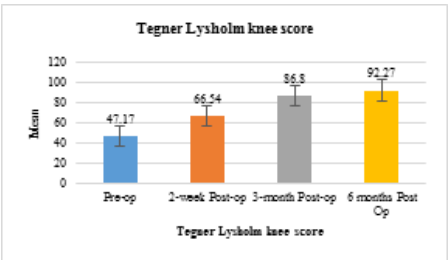
Knee flexion at Pre-op, majority had 0-100 degree flexion (36.6%), at 2 weeks, majority of them had 0-60 degree flexion, at 6 weeks, majority had 0-100 degree flexion (48.8%), at 3 months, majority of them had 0-120 degree flexion (58.5%) and at 6 months, majority of them had 0-120 degree flexion (585%).

In the study 1 patient had Re-rupture.at 3 months post-op. In the study, Bioabsorbable Interference screw was used in all the subjects. Median IKDC score at Pre-op was 14.00, at 2

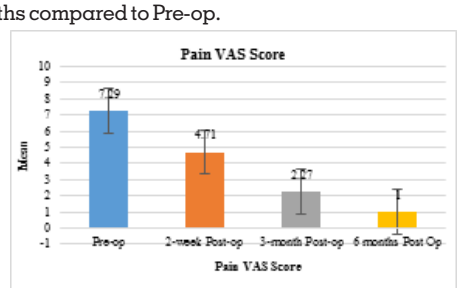
weeks was 47, at 3 months was 72 and at 6 months was 81. There was a significant increase in median IKDC score at 2 weeks, 3 months, and 6 months compared to Pre-op.



Median Tegner Lysholm knee score at Pre-op was 48, at 2 weeks was 67, at 3 months was 89 and at 6 months was 94. There was significant increase in median Tegner Lysholm knee score at 2 weeks, 3 months and 6 months compared to Pre-op.



Median Pain VAS Score at Pre-op was 7, at 2 weeks was 5, at 3 months was 2 and at 6 months was 1. There was significant decrease in median Pain VAS Score at 2 weeks, 3 months and 6 months compared to Pre-op.



DISCUSSION:

Because of the increased active participation of young adults in sports and the increased prevalence of road traffic accidents, the number of ligamentous injuries in youth has gradually increased, with the majority involving the knee joint and a greater worry for ACL ligament injury. Arthroscopic reconstruction of the torn.

ACL has become the gold standard and one of the most routinely performed operations in orthopaedics, thus it has been thoroughly investigated, and the results of ACL reconstruction have received a lot of attention.

The primary goal of ACL restoration is to allow the patient to resume his daily activities while avoiding further damage to his meniscus and hence the onset of osteoarthritis.

Various studies have examined the use of grafts to restore injured ligaments and identified multiple graft choices, each with its own set of advantages.

In recent years, there is a growing agreement in arthroscopic ACL reconstruction combined with ALL reconstruction in high pivoting patients, which has proven to be superior to ACLR alone in enhancing functional post-operative activity.

In our study, we reconstruct the injured ACL arthroscopically followed by ALL reconstruction with LET using Modified Lemaire's Procedure in high-risk knees and follow them up postoperatively to evaluate the clinical and functional outcome using the Lachman test, Pivot Shift Test, Tegner Lysholm Score, and IKDC scores, respectively.

Aside from improvements in arthroscopic ACL reconstructive surgeries, the percentage of graft ruptures remains between 3% and 12% of cases when solitary ACL restoration was performed. The reasons for early and late graft ruptures were investigated, taking into account the biological integration of the tendon graft as well as biomechanical considerations.

Early graft rupture was caused by disorganized initial tension and graft fixation, whereas late graft rupture was caused by poor biological integration.7According to Salmon and Shelbourne, the ruptures were caused by vigorous physical activity and graft weakening.

All of this necessitated the development of a new surgical approach for reconstructing the ACL, one that would allow for firm biological integration of the graft and speedy postoperative recovery for patients.

So, the technique of surgical reinforcement of ACL was innovated, and LET augmentation was added in order to overcome the graft failure due to rupture, which persisted in high-performance athletes.

Rotatory knee laxity was assessed at degrees of knee flexion. The intervention of ALL by LET resulted in considerable reductions.8

Bo-Ram Na et al. reported in a study that combined ACLR with LET resulted in improved pivot shift grades and lower graft failure rates than unilateral ACLR, regardless of the LET technique or time from injury to surgery.9

Stefano Zaffagnini et al. found that the ACLR with LET augmentation provided good outcomes in laxity control at 20-year minimum follow-up. 10 This study also emphasized the considerable improvement of Tegner Lysholm score. Immediately following surgery

In our study, the postoperative Tegner Lysholm score at 2 weeks was fair in all the patients, which subsequently improved to good in 36% of patients and excellent in 64% of cases, or 15 patients. At three months after surgery, 26 patients achieved outstanding Tegner Lsyholm grading. Overall, the Tegner Lysholm grade at 6 months postoperative was outstanding in 88% of patients, and good in 12%.

Gusti Ngurah Wien Aryana, et al conducted a meta-analysis and concluded that LET augmentation in ACL reconstruction enhanced cell proliferation, revascularization, and regeneration of proprioceptive organs in the reconstructed ACL and reduced rotatory instability and significantly improved the functional outcomes postoperatively as evaluated by improvement in IKDC scores. 11

In our study, the mean IKDC score was 14, but the postoperative mean IKDC score grew to 48 in all patients after two weeks, steadily improving to 71 over three months. Overall, the average IKDC at 6 months postoperative was excellent in 78 individuals.

Devitt et al 12 did a study and concluded that in primary ACLR, there is no evidence suggesting additional advantage of LET in minimizing postoperative pivot shift in early reconstructions (≤12 months); however, LET may have a role in delayed ACLR. In our study, one patient had a persistent pivot shift positive post-operatively after three months, prompting us to investigate the prospect of current ALL reconstruction for the

same in order to improve functional outcomes.

According to Getgood et al., 13 adding LET to a single-bundle hamstring tendon autograft ACLR in young patients at high risk of failure leads in a statistically significant, clinically relevant reduction in graft rupture and persistent rotatory laxity two years following surgery. In our study 2.43% of the patient had graft rupture.

CONCLUSION:

Modified Lemaire's approach for arthroscopic ACLR with LET promotes early graft healing, improving functional outcomes, minimizing rotatory instability, and allowing for early return to activity in high-risk knees.

One patient experienced graft re-rupture after 3 months of follow-up due to implant failure, reduced significantly with ACLR and LET combined. The study showed significant improvement in clinical (Anterior drawer test, Lachman's test, Pivot Shift Test) and functional (Tegner Lysholm Score, IKDC) outcomes after 6 months.

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