International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2022): 7.942

Evaluation of the Outcomes of Combined Lateral Meniscus Posterior Root and Anterior Cruciate Ligament Reconstruction

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Abstract: ***This study investigates the functional outcomes of combined arthroscopic repair of lateral meniscus posterior root tears LMPRT with anterior cruciate ligament reconstruction ACLR in patients with concurrent injuries. Conducted prospectively at Vikhe Patil College, the study included patients over 18 years with concomitant ACL tears and LMPRTs, identified through MRI or arthroscopy. The results show significant improvements in knee function and stability, as measured by IKDC, KOOS, and Lysholm scores, following the combined surgical procedure. The findings suggest that the repair of LMPRTs alongside ACLR can restore knee kinematics, enhance rotational stability, and potentially delay degenerative joint disease, highlighting the importance of addressing both injuries for optimal patient outcomes. Aim: Assess the functional outcomes of combined arthroscopic repair of an LMPRT with ACLR in consecutive patients who were evaluated with this injury combination. Methodology: It is a prospective study conducted in the period of July 2022 to July 2024 which had fulfilled the inclusion and exclusion criteria. Those who enrolled as said in inclusion criteria were all patients who were >18 years of age and concomitant ACL tear and LMPRT diagnosed on preoperative magnetic resonance imaging (MRI) scan and/or at arthroscopy. Examination under anaesthesia was followed by diagnostic arthroscopy. Results: On MRI examination we observed an LMPRT in 26.67% patients and radial/oblique posterior-third lateral meniscal tear in 33.33% patients. In almost half of patients, the LMPRT could only be diagnosed arthroscopically along with a concomitant medial meniscal tear. All these tears were repaired, and no meniscectomies were undertaken. The choice of ACL graft (bone- patellar tendon-bone [BPTB]) or 5-strand hamstring tendon (HT) graft. 1 patient underwent subchondral drilling and another patient underwent chondroplasty. Conclusion: Arthroscopic repair of an LMPRT combined with ACLR led to good clinical outcomes in the short term. An LMPRT may frequently go undetected on preoperative MRI scans, but a high-grade pivot shift is present in the majority of these patients.***

Keywords: meniscal injuries, ACL tear, LMPRT, knee stability, arthroscopic repair

1. Introduction

Meniscal injuries are frequently associated with anterior cruciate ligament (ACL) tears, and the reported incidence at the time of arthroscopy varies widely from almost 31% to 80%.[1,2] The lateral meniscus is more mobile than the medial meniscus and is more frequently injured in association with an acute ACL tear.[3,4] Lateral meniscus posterior root tears (LMPRTs) also occur more commonly in association with ACL tears (5%-10% of ACL tears) than as isolated lesions (<1% of all LMPRTs).[5,6] The posterior root attachment of the lateral meniscus is located posteromedial to the lateral tibial eminence apex, anterior to the posterior cruciate ligament (PCL) tibial attachment, and anterolateral to the medial meniscus when external rotation of the tibia occurs. The resultant traction on the posterolateral meniscus root leads to its rupture in association with the ACL tear.

The biomechanical consequence of LMPRT in an ACL-deficient knee is a decrease in contact area and increase in mean and peak lateral compartment contact pressures. This effect is more pronounced at higher flexion angles.[7,8] Additional injury to the meniscofemoral ligaments (MFLs) leads to a further increase in lateral compartment contact pressure.[9] Lateral meniscus extrusion is also seen in association with this injury pattern, especially when there is a complete tear involving both the direct LMPRT attachment and the MFL.[10]

In addition to load sharing, the integrity of the posterior root of the lateral meniscus is critical for aiding rotational stability. There is good evidence from cadaveric studies demonstrating the restoration of knee kinematics when the LMPRT is repaired. Transtibial repair of the LMPRT in association with ACL reconstruction (ACLR) can restore tibiofemoral contact mechanics, improving stability on anterior translation and pivot-shift loading at lower flexion as well as internal rotation at higher flexion angles.[11,12]

In robotic testing on human cadaveric knees, an untreated posterolateral root tear has been shown to result in increased anterior tibial translation on application of anterior force after an ACLR.[13] Reduction in the sagittal plane lateral meniscus extrusion and subsequent delay of degenerative joint disease has been clinically demonstrated after concomitant ACLR and LMPRT repair.[14] The present study was performed to assess the functional outcomes of combined arthroscopic repair of an LMPRT with ACLR in consecutive patients who were evaluated with this injury combination.

2. Materials and Methods

It is a prospective study conducted in the Orthopaedics department of Vikhe Patil College, Ahmednagar during the period of July 2022 to July 2024.

Inclusion criteria
- Age >18 years
- Concomitant ACL tear and LMPRT diagnosed on preoperative MRI scan and/or at arthroscopy
- A contralateral healthy knee
- Patients willing to give informed consent

Exclusion criteria

- Revision ACLR
- Multi ligament knee instability
- Coronal plane malalignment sufficient to warrant osteotomy.

3. Data Collection

After approval from Ethical Committee and obtaining informed consent form from the patients, preoperative patient data, details about mechanism of injury, and duration since injury were noted. A contact injury was defined as direct trauma to the knee sustained as a result of participation in any sport, sustaining a fall, or a motor vehicle accident. All other patient-reported outcome measures (PROMs) were assessed using the International Knee Documentation Committee (IKDC) score,[15] Knee injury and Osteoarthritis Outcome Score (KOOS),[16] and Lysholm score.[17]

Examination under anaesthesia was performed, and the Lachman test and pivot-shift laxity were graded using IKDC scores.[18] Intraoperative data including LMPRT type (as classified by Forkel and Petersen[19]), technique of LMPRT repair, and associated medial meniscus or articular cartilage surgery performed were collected. The Forkel and Petersen classification was used as it is specific for LMPRT only and takes into consideration the integrity of MFL as well. Postoperatively, all patients were followed up after 3 weeks, 6 weeks, 3 months, and every 6 months thereafter. PROMs were assessed at the end of 1 and 2 years.

ACL graft laxity was assessed on clinical examination using Lachman and pivot- shift tests in the clinic by an independent examiner (A.S.). All patients were followed up for a minimum of 24 months post-surgery.

4. Surgical Technique

Examination under anaesthesia was followed by diagnostic arthroscopy. Any medial meniscus or cartilage pathology was treated first. The knee was then placed in the figure- of-4 position to effectively view and assess the LMPRT from the anterolateral portal. Probing was performed to check for the status of the MFLs. The choice of ACL graft (bone- patellar tendon-bone [BPTB]) or 5-strand hamstring tendon (HT) graft was determined using tibial footprint measurement and activity type. Patients with an ACL tibial footprint width >10 mm and those engaged in contact sports were selected for a BPTB graft. The ACLR femoral tunnel was drilled at the mid-anteromedial bundle footprint using the trans accessory medial portal technique.

The LMPRT was repaired after this according to type. For type 2 radial tears, side-to-side repair using 2 No. 0 Fiber-Wire sutures were performed using the Knee Scorpion self-suture retrieving device. The knots were tied on the superior or inferior surface of the meniscus in order to achieve a simple-suture configuration.

For types 1 and 3 tears, a bony bed was created at the centre of the anatomic root attachment site using a curette and shaver. A meniscus root repair guide was inserted from the anteromedial portal, and a transtibial tunnel was created using a 4.5-mm drill bit over a 2.4-mm passing pin. A No. 0 Fiber Wire was passed using a Knee Scorpion device through the meniscus root. A Suture Tape loop was then shuttled across to achieve a luggage-tag stitch through the root. The step was repeated so as to have 2 tapes passing through the root. The ACL tibial tunnel was then drilled at the centre of the ACL footprint. Special care was taken to maintain an adequate bone bridge between the lateral meniscus root repair and ACL tunnels on the tibial cortex. The 4 Suture Tape ends were retrieved through the transtibial lateral meniscus root repair tunnel and tied over a 4.5-mm post fixation screw with the knee in 30° of flexion. Finally, the ACL graft was passed and fixed with the knee in 20° to 30° of knee flexion. HT grafts were fixed in the femur using a cortical button and, in the tibia, using an interference screw. BPTB grafts were fixed in the femur and tibia using a titanium interference screw.

Rehabilitation

A phased program was initiated postoperatively. All patients wore an extension knee brace and were non- weightbearing for the first 4 weeks after surgery, followed by progression to full weightbearing after 6 weeks. Passive range of motion from 0° to 90° was allowed immediately postoperatively for 4 weeks. Endurance training was begun after 10 weeks, and strength training was begun after 16 weeks. Squatting was limited to 70° in the initial 4 months. Running was allowed after 5 to 6 months, and those engaged in sports activities were allowed to return to play only after 9 to 12 months.

Statistical Analysis

The data analysis was performed using Excel 2021 software (Microsoft Corp) and IBM Corp. Released 2023. IBM SPSS Statistics for Windows, Version 29.0.2.0 Armonk, NY: IBM Corp. Qualitative data variables are expressed as frequency and percentage, while quantitative data variables are expressed as mean and standard deviation or median and range (minimum-maximum). The continuous variables were analysed using nonparametric tests. The Wilcoxon signed rank test was used to analyse differences between pre- and postoperative IKDC score, KOOS, and Lysholm score. $P < .05$ was considered statistically significant.

5. Results

The characteristics and intraoperative details of the patients are provided in Table 1. The right knee was injured in 53.33% patients, and the left was injured in 46.67, with 60% patients reporting a contact injury mechanism. On MRI examination we observed an LMPRT in 26.67% patients and radial/oblique posterior-third lateral meniscal tear in 33.33% patients.

Thus, in almost half of patients, the LMPRT could only be diagnosed arthroscopically. 33.33% patients had a concomitant medial meniscal tear. These included a ramp lesion in 13.33%, peripheral longitudinal tear in 13.33%, and horizontal cleavage tear in 6.67% patient. All these tears were repaired, and no meniscectomies were undertaken. 1 patient underwent subchondral drilling for a 6 x 8-mm grade 4 lesion of the medial femoral condyle, and another patient underwent chondroplasty for a 4 x 6-mm grade 3 lesion of the lateral tibial plateau.

A BPTB graft was used for ACLR in 4 patients, and a 5-strand

HT graft was used in 86.67% patients. An LET using a strip of iliotibial band was performed for 20% patients. Partial coalition of tibial ACLR and LMPRT repair tunnels was seen in 13.33% patients, while a common tunnel was used in 1 patient because of the near-total coalition.

Table 1: Patient and clinical characteristics

Characteristics	Percentage of cases / Mean±S.D
Age	28.5±6.3 (18-35)
Gender	
Male	53.33%
Female	46.67
BMI	26.7±4.1 (21.5-35.4)
Mode of Injury	
Sports	66.67%
Fall	6.67%
RTA	26.66%
Pivot Shift test grade	
1	6.67%
2	20%
3	73.33%
Concomitant injury	
Medial meniscal tear	33.33%
Cartilage lesion	13.33%
Type of LMPRT	
1	53.33%
2	6.67%
3	40%

Table 2: Outcome

	Preop	Post op follow up	P value
IKDC score	46.4±**9.4**	82.7±**11.3**	< 0.001**
KOOS	44.6±**10.7**	87.5±**10.2**	<0.001**
Lysholm score	48.5±**11.3**	88.4±**7.5**	<0.001**

6. Discussion

A definitive MRI diagnosis of an LMPRT preoperatively was possible only in a minority of patients. The preoperative high-grade pivot shift present in 7.33% of our patients could have been due to the contribution of the tear of the posterolateral meniscus root causing anterolateral rotatory instability in an ACL-deficient knee. This is, to the best of our knowledge, the first report of clinical outcomes of repairing LMPRTs using an independent tunnel drilling technique.

There are several risk factors for an LMPRT along with an ACL tear. Participation in contact sports and the presence of a concomitant medial meniscal tear were identified as independent risk factors in an epidemiological study of 3956 patients by Praz et al.[20] Okoroha et al[21] found an association between LMPRTs and abnormal varus of the tibia, higher posterior tibial slope, and higher body mass index. A majority of the study participants (73.33%; 11/15) sustained a contact injury, while a concomitant medial meniscal tear was present is 33.33% patients. The mean body mass index of patients in this series was 26.7 ± 4.1, which is also in the "overweight" category. Most ACL tears occur in noncontact injuries. Della Villa et al[22] found that 88% of ACL tears in a cohort of professional soccer players had a noncontact or indirect contact mechanism. Therefore, since the present study of ACL tears with LMPRTs had 73.33% of patients with contact injury, which is much higher than the 12% mentioned in the aforementioned study, there may be an association between contact injury, the extra violence involved, and an LMPRT.

In a cadaveric experiment using infrared camera motion analysis, Shybut et al[23] demonstrated that the mean anterior tibial translation of the lateral tibial condyle significantly increased on pivot-shift loading when the lateral meniscus posterior root was avulsed compared with an isolated ACL-deficient state. Forkel et al[24] additionally demonstrated that while an isolated root tear increased internal rotation laxity at 60° and 90° of knee flexion alone, additional injury to the MFLs increased this instability at all flexion angles. Clinical studies have also demonstrated that a complete LMPRT in the presence of an ACL tear is an independent risk factor for the prevalence of high-grade (grades 2 and 3) anterolateral rotatory instability, especially in injuries >12 weeks.[25] Although there is evidence from cadaveric studies[11,22,29,36] on the detrimental biomechanical effects of an LMPRT in an ACL-deficient knee and the benefit of repairing that lesion, clinical data on the management and outcomes of this injury complex are sparse.

In a retrospective comparative study of 31 LMPRTs that underwent transtibial repair versus matched 31 tears that were treated non surgically, Pan et al[14] reported higher IKDC and Lysholm scores in the repair group. Although this difference was not statistically significant, a higher rate of radiographic arthritis (6 mild, 8 moderate, and 2 severe) after a minimum 2-year follow-up was seen in those whose LMPRTs were not repaired. The relative contribution to improved knee function reported in the present study from the ACLR and repair of LMPRT is, however, impossible to assess. A level 4 systematic review of 9 nonrandomized studies with 215 patients reported favourable functional outcome after combined ACLR and LMPRT repair with a meniscus healing rate >90%.[26]

Forkel and colleagues[27] have advocated the use of the ACL tibial tunnel or, in the double-bundle ACLR technique, the posterolateral bundle tibial tunnel for passing the fixation sutures through the tibia. They also demonstrated in a cadaveric experiment that an independent tibial tunnel for the posterior root is not necessary. Although a biomechanically sound option, such a technique does not restore the anatomic attachment of the lateral meniscus posterior root.

The lateral meniscus is a known secondary restraint to anterolateral tibial motion in the pivot-shift phenomenon.[23,25] A high-grade pivot shift seen in 73.33% of patients in the current series also affirmed this phenomenon. Medial meniscus ramp lesions, high tibial slope, and damage to the anterolateral soft tissues also contribute to the magnitude of pivot shift, and the mere presence of a high-grade pivot shift is not specifically related to LMPRTs.

However, since using preoperative MRI for diagnosing LMPRTs is still challenging owing to its low sensitivity, whenever a high-grade pivot shift is found, the surgeon should consider the possibility of LMPRT.

This study has several limitations. First, while the outcomes presented are encouraging, the follow-up is short term, and sustained improvement in functional outcomes and future chondral deterioration needs to be assessed on longer follow-up. Second, no instrumented laxity measurements pre- and postoperatively were available to assess the effect of the LMPRT and its repair on laxity. However, none of the patients reported instability or had excess ACL laxity on clinical examination at the final follow-up. Third, the long interval between injury and surgery makes it difficult to pinpoint if the lateral meniscus root tore at the time of index trauma or during subsequent episodes of instability. Fourth, different types of repairs were used for various tear patterns, thus making the cohort less homogeneous, but this reflects the spectrum of LMPRTs. Fifth, no MRI scan or second-look arthroscopy was performed to evaluate the healing of LMPRT repairs. Finally, there was no control group with which to objectively compare the outcomes of surgery. However, this was because the authors believe that a tear of the lateral meniscus root should always be repaired, in view of existing evidence of its role in knee stability and function.

7. Conclusion

Arthroscopic repair of an LMPRT combined with ACLR led to good clinical outcomes in the short term. An LMPRT may frequently go undetected on preoperative MRI scans, but a high-grade pivot shift is present in the majority of these patients.

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