Stable lateral meniscal posterior root tears left in situ at time of anterior cruciate ligament reconstruction are of minimal long-term clinical detriment

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This article was originally published as:

Original article available here:
10.1016/j.arthro.2021.04.075

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Stable Lateral Meniscal Posterior Root Tears left In Situ at Time of Anterior Cruciate Ligament Reconstruction Are of Minimal Long-Term Clinical Detriment


Purpose: The purpose of this study was to compare long-term patient-reported outcomes in patients undergoing anterior cruciate ligament (ACL) reconstruction with untreated stable lateral meniscal posterior root (LMPR) tears to those with an intact meniscus. Methods: Four hundred ninety-two subjects were followed for a minimum of 15-years post-ACL reconstruction and evaluated by an International Knee Documentation Committee questionnaire. The integrity of the meniscus was classified at surgery. Patients were grouped as either untreated injury to LMPR "with stable tear" (WST) group (n = 52) or intact lateral meniscus "no tear" (NT) group (n = 440). WST group included tears where those with a root avulsion within 9 mm of insertion and parrot beak tears with the integrity of the root attachment maintained. Outcomes were compared between groups. Results: ACL graft rupture occurred in 10% in the WST group and in 11% in the NT group (P = .78). For participants with an intact graft (n = 440), the mean International Knee Documentation Committee scores were 82, in the WST group, and 87, in the NT group (P = .03), with a small effect size of .32. The WST group had a worse mean pain severity score (P = .04) and higher frequency of pain (P = .03) than the NT group, but the effect size was small (P < 0.3). There was no difference in the overall knee function (P = .209) or International Knee Documentation Committee activity level (P = .882). Conclusion: There was no adverse clinical outcome to leaving a stable LMPR tear in situ at the time of ACL reconstruction. LMPr tears left in situ were of minimal clinically significant long-term detriment, with outcomes similar to having an intact meniscus. There is an innate desire to fix the broken, but posterior meniscal root avulsions and stable parrot beak tears within 9 mm of insertion may not require intervention. At 15 years postinjury, most patients with a stable tear left in situ continue to enjoy an active lifestyle with a pain-free knee. Level of Evidence: Level III, retrospective comparative study.

Introduction

Meniscal tears are a common occurrence observed in acute injury to the anterior cruciate ligament (ACL), with up to 82% of ACL injuries having associated meniscal pathology. Acute lateral meniscus posterior root (LMPr) injuries have been reported to occur in 12.4% of patients with ACL rupture, with less than 1% occurring as an isolated knee injury. Furthermore, the posterior root of the lateral meniscus is 10.3 times more commonly injured in acute ACL rupture than that of the medial meniscus.

The meniscus plays an integral role in knee joint stability, proprioception, and transmitting axial force, with the roots of the meniscus being particularly important to prevent extrusion. Tears to the posterior root of the meniscus have become of increased interest, given improved identification, the concern of progression of arthrosis if left untreated, and the expansion of the market of new devices available to repair such injuries. LMPr injuries are defined as a tear that occurs within 9 mm from the posterior bony insertion of the lateral meniscus.
There is concern that such tears, if left untreated, will alter the kinematics of the knee and result in early degenerative changes, and repair is considered the standard for joint preservation. Many methods of fixation of LMPR injuries have been developed with the aim of restoring the native structure. However, it has been reported that LMPR tears (LMPRTs), posterior to the popliteus tendon, may heal spontaneously and remain asymptomatic in short-term follow-up. The question thus arises as to whether LMPR fixation will improve long-term outcomes.

The purpose of this study was to compare long-term patient-reported outcomes in patients undergoing ACL reconstruction with untreated stable LMPRT to those with an intact meniscus. We hypothesized that at 15-year follow-up, there would be no negative effect of lack of intervention and that those patients with LMPRTs would have scores equivalent to those with no meniscal injury.

**Methods**

All subjects underwent primary ACL reconstruction under the care of a single surgeon in Sydney, Australia, using the same technique. The inclusion criterion was primary ACL reconstruction with autograft between 1993 and 1994 under the care of the senior author (L.A.P.). The following exclusion criteria were applied: abnormal contralateral ACL, refused research participation, deceased, those receiving compensation for their injury, those who had undergone subsequent surgery to either knee, and those who were unable to complete the questionnaire. Those patients with a meniscal tear deemed to be unstable to arthroscopic probe were also excluded from the final analysis.

These data were initially collected to determine the rate of further ACL injury to the reconstructed and contralateral knee and have been previously reported. For the purposes of this study, participants were grouped according to the status of their lateral meniscus at the time of ACL reconstruction into 1 of 3 groups:

- Those with untreated injury to the posterior horn of the lateral meniscus (the “with stable tear” [WST] group)
- Those with an intact lateral meniscus (“no tear” [NT] group)
- Those who underwent resection or repair to their lateral meniscus in a region other than the posterior horn

Those who underwent resection or repair of the lateral meniscus in a region other than the posterior horn were excluded because we wanted to focus on LMPRT, and intervention with resection or suturing of a meniscal tear represented a different pattern of injury not controlled for in this study. Intervention was used if the meniscal tear was determined to be unstable by arthroscopic probe. The remaining 492 subjects formed the study group for analysis.

All operations were performed by a single surgeon (L.P.) at a single center using the same method. At the time of surgery, the integrity of the meniscus was evaluated, and the type of tear and location, if present, were recorded. Posterior meniscal root tears were defined as those within 9 mm of root insertion. It was the senior author’s practice not to perform any repairs to tears in this specific area. The tears left in situ were of 2 distinct types, both stable to arthroscopic probe: a lateral meniscal posterior horn root avulsion, without a tear in the meniscus itself (see Fig 1), and a parrot beak tear with the base at the posterior horn root attachment (see Fig 2). Stability of the tear was determined by displacement by arthroscopic probe. The unstable parrot beak, which may or may not be displaced, was excised and not included in analysis (see Fig 3). The remaining meniscus, although intact, was effectively defunctioned with respect to hoop tensile forces. These subjects formed the WST group. Those with any other type of lateral meniscal injury in a region other than the posterior horn were excluded regardless of treatment (see Fig 3).

The method of ACL reconstruction has previously been described. Patients received an autograft of either 4-strand hamstring tendons prepared with whipstitch or patella tendon with bone blocks. Femoral tunnels were drilled via the anteromedial portal and were placed 5 mm anterior to the posterior capsule at the 11-o’clock or 1-o’clock position for the right and left knee, respectively. The tibial tunnel was prepared with a drill guide placed at the footprint of the ACL, one-third of the way along a line from the anterior horn of the lateral meniscus to the medial spine of the tibia. Fixation was with a titanium RCI screw (Smith & Nephew; Andover, MA).
MA) on both the femoral and tibial side, with a reverse thread screw used for the femoral tunnel of the right knee. The presence of chondral injuries was recorded but not graded by severity. All patients underwent a standard accelerated rehabilitation protocol used for all ACL reconstructions at our institute, with postoperative day 1 weight-bearing and range of movement exercises.

Ethical approval for this study was sought and granted, after submission of the study protocol, by a local independent human ethics committee (St Vincent’s Hospital, Sydney, Australia).

At a minimum of 15 years after surgery, subjects who met the inclusion criteria were contacted via email or telephone. Those agreeing to participate were given a questionnaire with the full International Knee Documentation Committee (IKDC) analysis as well as a list of questions related to subsequent injuries to the knee and any further surgery to the knee.

Statistical analysis was performed using SPSS software, version 25 (IBM; Chicago, IL). Statistical significance was set at $P < .05$. Between-group comparisons of the linear variables, such as subjective IKDC scores, were made using an independent $t$-test; categorical variables were compared with $\chi^2$ tests. Effect size was assessed with Cohen’s $d$. Cohen suggested that $d = 0.2$ be considered a small effect size, 0.5 a medium effect size, and 0.8 a large effect size. A minimally important change was used to evaluate the clinical significance of subjective assessment.

**Results**

Between 1993 and 1994, 891 participants underwent primary ACL reconstruction by a single surgeon at a single center. Exclusion criteria were applied as follows: abnormal contralateral ACL ($n = 97$), refused research participation ($n = 8$), deceased ($n = 11$), those receiving compensation for their injury ($n = 15$), those who had undergone subsequent arthroplasty surgery ($n = 4$), and those who were unable to complete the questionnaire ($n = 1$). Of the 4 subjects who underwent arthroplasty surgery, 3 had an intact lateral meniscus and 1 had a lateral meniscectomy. There were 755 participants who met the inclusion criteria. At follow-up, 673 participants (89%) had completed the subjective review at a minimum of 15 years (mean, 16 years, 10 months; range, 15 to 18 years); 82 subjects (11%) were lost to follow-up and excluded from the analysis.

As the purpose of this study was to determine a difference in patient-reported outcomes measures between those with untreated injury and those with no injury, the group with resection or repair of the meniscus was excluded from further analysis ($n = 181$). The final group studied consisted of 492 subjects, with either an intact lateral meniscus at the time of reconstruction (NT group, $n = 440$) or stable tear to the posterior lateral meniscal root without intervention (WST, $n = 52$). The WST group consisted of 28 subjects who had a posterior horn root avulsion, without a tear in the meniscus itself (see Fig 1), and 24 who had a parrot beak tear with the base at the posterior horn root attachment (see Figs 2 and 3). Participant flow is shown in Figure 4.

The demographic and surgical characteristics of each group at the time of ACL reconstruction are shown in

![Fig 2. Arthroscopic view of a lateral meniscal posterior horn beak tear in a right knee viewed from the lateral portal.](image)

![Fig 3. Arthroscopic view of the lateral meniscal posterior horn beak tear after removal of the displaced fragment in a right knee viewed from the lateral portal.](image)
Table 1. There was no significant difference between the 2 groups.

Over 15 years, ACL graft rupture occurred in 5 participants of 52 (10%) in the WST group and 48 of 440 (11%) from the NT group ($P = .78$). Contralateral ACL injury occurred in 6 participants of 52 (12%) of the WST group and 69 of 440 (16%) from the NT group ($P = .432$).

Subject analysis was recorded from those patients with intact ACL graft ($n = 440$). The mean IKDC score at 15 years was 82 (SD, 16) for the WST group and 87 (SD, 14) for the intact group ($P = .03$). Figure 5 shows the box plot for overall IKDC score at 15 years.

When the IKDC scores were broken down into subcomponents, there was found to be a significantly poorer mean pain severity score and reportedly higher frequency of pain in the WT group ($P = .04$ and $P = .03$) (Table 2). There was, however, no difference in the overall knee function ($P = .209$). Furthermore, there was no significant difference in swelling or mechanical symptoms.

There was no significant difference in the reported activity level at 15 years ($P = .882$), with 55% of participants in the WST group and 52% of participants in the NT group reporting regular strenuous or very strenuous activity (Fig 6).

**Discussion**

The findings from this study suggest that LMPRTs left in situ are of minimal clinically significant long-term detriment, with clinical outcomes similar to having an intact meniscus. The effect size between the groups on the IKDC subcomponents ranges from 0.1 to 0.3, representing a small effect. Thus, even with statistically significant different results in pain severity and frequency, the magnitude of the effect of LMPRT over

Table 1. Demographics of the WST and NT Groups

<table>
<thead>
<tr>
<th></th>
<th>WST group</th>
<th>NT group</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of participants</td>
<td>52</td>
<td>440</td>
<td>.710</td>
</tr>
<tr>
<td>Mean (SD) age in years</td>
<td>28.7 (9.4)</td>
<td>29.2 (9.4)</td>
<td>.471</td>
</tr>
<tr>
<td>No. of males (%)</td>
<td>34 (65)</td>
<td>265 (60)</td>
<td>.459</td>
</tr>
<tr>
<td>No. of hamstring tendon grafts (%)</td>
<td>30 (58)</td>
<td>230 (52)</td>
<td>.827</td>
</tr>
<tr>
<td>No. of patellar tendon grafts (%)</td>
<td>22 (42)</td>
<td>210 (48)</td>
<td>.912</td>
</tr>
<tr>
<td>No. with no medial meniscectomy (%)</td>
<td>39 (75)</td>
<td>336 (76)</td>
<td></td>
</tr>
<tr>
<td>Concurrent medial ligament repair (%)</td>
<td>4 (8)</td>
<td>40 (8)</td>
<td>.141</td>
</tr>
<tr>
<td>Femoral chondral injury (%)</td>
<td>14 (27)</td>
<td>81 (18)</td>
<td></td>
</tr>
<tr>
<td>Tibial chondral injury (%)</td>
<td>4 (8)</td>
<td>26 (6)</td>
<td>.611</td>
</tr>
<tr>
<td>Patella chondral injury (%)</td>
<td>6 (12)</td>
<td>41 (9)</td>
<td>.606</td>
</tr>
</tbody>
</table>

NT, “no tear”; WST, “with stable tear.”
15 years was minimal on patient-reported outcomes (Cohen \(d\) of 0.3 or less). Although there was found to be a statistically significant difference in the overall IKDC scores (82 in the WST group vs 87 in the NT group, \(P = .03\)), again the effect size was small, at 0.32, and certainly well below that reported by others, 2.1, for responsiveness of the IKDC score after meniscal surgery\(^{18}\), thus the observed difference of 4.8 points may not translate to knee function. This is indicated by the lack of significant difference in overall knee function between the 2 groups \((P = .209)\) as well as return to activity level \((P = .882)\). At 15-year follow up, 55% of the WST group and 52% of the NT group reported regular participation in strenuous or very strenuous activity. Given the duration of the follow-up, these participants would be approaching a mean age of 45 years. There is a strong notion in the current literature that there are few scenarios in which one would not repair a root tear and risk condemning a patient to early osteoarthritis.\(^{9,19}\) With equivalent clinical outcomes between the groups and more than half of all participants continuing to be involved in strenuous activity in their mid-40s, this suggests that proponents of LMPR repair need further evidence to warrant their repair.

Shelbourne et al. found a similar result, with an average IKDC score of 84.6 10 years after an LMPR injury was left in situ.\(^{20}\) When compared with a matched control group without meniscal injury, there was no subjective or clinical objective difference between the 2 groups. Second-look arthroscopy has shown that the LMPR can heal completely without intervention in 69% of participants.\(^{21}\) It has also been found that in comparing acute and chronic ACL tears, there is a lower incidence of LMPRTs in the chronic group, suggesting that a large proportion of them heal.\(^{15}\)

Although Shelbourne et al. found that there was no significant difference between an LMPRT and an intact meniscus with regard to subjective evaluation with IKDC scores and objective evaluation of range of movement and KT-1000 at an average of 10 years post-ACL reconstruction, there was a 1-mm loss of lateral joint space on radiographs in the LMPRT group compared with control.\(^{20}\) Initial joint space narrowing is most commonly attributable to extrusion of a meniscus.\(^{22}\) Radiographic and objective investigations would have strengthened the study in determining long-term effects of a stable LMPRT left in situ. Despite this possibility, we argue that the main marker of surgical success should be clinical outcomes and patient satisfaction, not imaging reports or the elegance of a surgical procedure, thus making it difficult to justify additional surgical intervention for stable tears of the LMPR.

There is no denying the importance of the meniscus in the preservation of knee function.

Allaire et al. found that a posterior root tear to the medial meniscus has the same biomechanical consequence as a total meniscectomy.\(^{10}\) Compared with the medial meniscus, the posterior lateral meniscus has a more complex attachment including the supplementary attachments to the tibial plateau, the meniscofemoral ligament, the transverse genual ligament, and the popliteal tendon.\(^{7,23,24}\) If the tear is medial to the attachment of the popliteal tendon, the literature suggests that there is sufficient attachment to maintain stability and to heal in the anatomical position.\(^{14,20,21}\)

Attempts of meniscal repair are not without complications. It has been well documented that failing to replace the medial meniscus back to anatomical position promotes knee deterioration.\(^{15,26}\) With the current techniques, not all the supplemental fibers of the

### Table 2. IKDC Subjective Scores for the WST and NT Groups

<table>
<thead>
<tr>
<th></th>
<th>WST group</th>
<th>NT group</th>
<th>(P) value</th>
<th>Effect size (Cohen (d))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean IKDC score/100 (SD)</td>
<td>82 (16)</td>
<td>87 (14)</td>
<td>.03</td>
<td>0.32</td>
</tr>
<tr>
<td>Mean pain severity score/10 (SD)</td>
<td>7.9 (2.5)</td>
<td>8.6 (2.2)</td>
<td>.043</td>
<td>0.29</td>
</tr>
<tr>
<td>Mean pain frequency score/10 (SD)</td>
<td>7.8 (2.9)</td>
<td>8.6 (2.4)</td>
<td>.034</td>
<td>0.30</td>
</tr>
<tr>
<td>Mean overall knee function score/10 (SD)</td>
<td>8.5 (1.9)</td>
<td>8.1 (1.9)</td>
<td>.209</td>
<td>0.21</td>
</tr>
<tr>
<td>Mean activity swell free/5 (SD)</td>
<td>4.1 (1.1)</td>
<td>4.6 (1.0)</td>
<td>.260</td>
<td>0.17</td>
</tr>
<tr>
<td>Mean catching symptoms/5 (SD)</td>
<td>2.0 (0.6)</td>
<td>1.9 (0.5)</td>
<td>.570</td>
<td>0.07</td>
</tr>
</tbody>
</table>

Higher IKDC scores represents fewer symptoms or less pain. Overall score maximum, 100; pain and function scores maximum, 10; swelling and catching scores maximum, 5. IKDC, International Knee Documentation Committee; NT, “no tear”; SD, standard deviation; WST, “with stable tear.”
meniscus are reattached, suggesting that we are not achieving a biomechanical or anatomical repair of the native meniscus. Given the location of the LMPR, there is a risk to the neurovascular bundle behind the popliteus tendon, and the technical difficulty of gaining access to the area puts the femoral condyle surface at risk. Commonly, patients after meniscal repair remain non-weight-bearing for 6 weeks in a brace, resulting in further muscle atrophy and increased risk of deep vein thrombosis and delay in rehabilitation. The main complication reported in the literature is failure of the LMPR repair. It has been reported on meta-analysis that the failure rate of a lateral meniscal repair on average is 20.2%, with a range from 6.7% to 42.9%. The failure load of the native LMPR has been calculated as 648 N. Comparatively, meniscal root repairs have been reported to have a tensile load of 143 to 184 N. Thus, a repair may have little effect other than maintaining the position of the meniscus in order for it to heal; this paper suggests that equivalent clinical outcomes can be achieved without surgical repair.

Limitations
The main limitation in this study is the selection bias by the surgeon as to which types of tears were considered to be left in situ compared with those that required repair. Stability was evaluated with a probe, and the meniscus was determined to be stable if the surgeon was unable to move the torn piece into the intercondylar notch or joint. Those tears that were determined by the surgeon to be unlikely to cause mechanical symptoms of locking or catching were not repaired. If a tear was considered to be unstable to probing, then it was debrided to a stable margin or repaired if amenable to and as such removed from the study. Other limitations include the retrospective design, which could be improved by a prospective and ideally randomized design. However, long-term outcomes with higher-level evidence for what is a relatively new shift in treatment for posterior lateral meniscal tears will be a decade away. In the interim, the existing evidence, although limited, is worthy of consideration and illustrates the natural progression of stable tears over 15 years. Furthermore, this study was not powered to determine rupture rates of ACL reconstruction surgery. The incidence has been reported, yet it is not possible to draw conclusions regarding reinjury rates between the groups.

Conclusions
There was no adverse clinical outcome to leaving a stable LMPRT in situ at time of ACL reconstruction. LMPRTs left in situ were of minimal clinically significant long-term detriment, with outcomes similar to having an intact meniscus. There is an innate desire to fix the broken, but posterior meniscal root avulsions and stable parrot beak tears within 9 mm of insertion may not require intervention. At 15 years postinjury, most patients with a stable tear left in situ continue to enjoy an active lifestyle with a pain-free knee.

Acknowledgment
The authors acknowledge the assistance of Dr. Alex Riddell in collating the results.

References
LATERAL MENISCAL POSTERIOR ROOT TEARS


