ORIGINAL ARTICLE

Partial ACL reconstruction with preservation of the posterolateral bundle

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Partial rupture;
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Posterolateral bundle

Summary
Introduction: Over the past decade, our understanding of the anterior cruciate ligament (ACL) has evolved considerably. Based on this knowledge, ACL reconstruction techniques have changed and selective reconstruction procedures have been developed for partial tears. Our hypothesis was that stability and function can be restored to the knee with selective bundle reconstruction of partial ACL tears and preservation of the residual fibers.

Materials and methods: This was a multicenter retrospective study of 168 partial reconstructions of the anteromedial (AM) bundle of the ACL with preservation of the posterolateral (PL) bundle. All patients underwent a clinical evaluation based on the objective and subjective IKDC scores and the Lysholm score after a mean follow-up of 26 months (12–59 months). Preoperative and postoperative instrumental measurement of knee laxity was performed by arthrometer and/or by (Telos®) stress radiography. Statistical analysis and comparison was performed between pre- and postoperative results.
Introduction

In the past 10 years understanding of the anterior cruciate ligament (ACL) has increased considerably. From an anatomical standpoint, the identification of two bundles [1] that are easily identifiable at arthroscopy [2,3], has resulted in a more precise description of the femoral and tibial insertion sites [4]. From a biomechanical point of view, there is now a better understanding of the function of each of these two bundles in the control of anteroposterior laxity and rotation [5]. This knowledge has changed ACL reconstruction techniques with the development of double bundle reconstruction or selective bundle reconstruction in partial tears [1,6]. The clinical results of published series of selective ACL reconstruction are good and show the biological importance of preserving fibers [6–12]. These preserved ACL fibers ensure vascularization and innervation thus favoring graft integration [13–16].

Our hypothesis was to confirm the principle of partial ACL reconstruction, which preserves residual fibers, restores stability and function to the knee. We report the results of a retrospective, multicenter study of 168 reconstructions of the anteromedial (AM) bundle of the ACL with preservation of the posterolateral bundle (PL) after a mean follow-up of 26 months.

Materials and methods

This was a retrospective, multicenter study including 11 centers. All of the patients in the study underwent isolated reconstruction of the AM bundle of the ACL with preservation of the PL bundle from 2006 to 2010. All the patients presented after trauma to the knee with clinical, radiographic and MRI signs of an ACL tear (Fig. 1). The decision to perform selective reconstruction of the AM bundle was always made during arthroscopy after thorough analysis of the ACL tear. Patients with recurrent tears, multi-ligament injury or a contralateral ACL tears were excluded. A total of 168 partial reconstructions of the ACL anteromedial bundle with preservation of the posterolateral bundle were performed. The mean age of patients at surgery was 30 years old (14–58). There were 105 men and 63 women. The cause of the ACL tear was a sporting injury accident in 91% of the cases, in the majority during a pivot-contact trauma (63% of the cases). The delay between injury to the surgery was 3 months (0–68).

After a mean follow-up of 26 months (12–59), all patients underwent a clinical evaluation based on objective and subjective IKDC scores and the Lysholm score. Pre- and postoperative knee laxity was measured instrumentally by goniometry and/or by Telos® stress radiography.

Statistical analysis was performed by StatEL @Science. The Chi² test was used to compare qualitative data and the Kruskall-Wallis and Mann/Whitney tests to evaluate preoperative and postoperative qualitative and quantitative data to compare laxity and subjective and objective IKDC scores. P = 0.05 was considered to be significant.

Surgical technique

An initial arthroscopy was systematically performed at the beginning of surgery to evaluate the type of tear. When there was an AM bundle tear while the PL bundle was continuous [2], selective reconstruction of the AM bundle was performed (Fig. 2). Three types of grafts were used for these reconstructions: hamstring tendon (n = 108 cases), patellar tendon (n = 55 cases) and quadricipital tendon (five cases). Depending on each surgeon’s usual practice, an inside-out (n = 90 cases) or outside-in (n = 78 cases) technique was used for the femoral tunnel.

The rehabilitation protocol was similar in all institutions; running was allowed 3 months after surgery, and contact sports after 6 months.

Results

Preoperatively all patients reported episodes of instability (83% of the cases) and/or pain (48% of cases). The clinical examination showed a positive Lachman test in 66% of the cases, with a delayed firm endpoint. There was a glide pivot-shift in 40% of the cases (n = 67). Pivot-shift was absent in 19% of the cases (n = 32), positive in 30% of the cases (n = 50) and gross in 11% (n = 19). The mean estimated preoperative laxity was 5.7 mm with the goniometer (n = 91 cases) and 5.3 mm with Telos stress radiography (n = 92 cases). Pivot-shift was statistically correlated to laxity (P = 0.04) and the longer the delay between the accident and surgery the stronger this relationship was (non significant P = 0.49).
Preoperatively 26% of the patients had lesions of the medial meniscus (\(n=28\) cases) or the lateral meniscus (\(n=16\) cases). All types of lesions were observed: bucket handle, radial tears, mobile flaps. A total of 13% of the patients underwent partial meniscectomy. Ten stage II (or more) chondral lesions were reported. Treatment included abstention in eight cases, one perforation and one osteochondral mosaicplasty-type graft.

The preoperative and postoperative subjective IKDC scores were 63.7 (range: 40–95) and 90.5 (range: 52–100) respectively at the final follow-up (\(P<0.001\)).

The preoperative and postoperative Lysholm scores were 80 (range: 44–95) and 95.5 (range: 53–100) respectively at the final follow-up (\(P<0.001\)).

Preoperatively most patients were classified as C on the objective IKDC score (\(n=94\) cases), and the remaining patients included one class A patient, 47 class B and 26 class D patients. At the final follow-up, IKDC scores included 114 class A patients, 40 class B, six class C and eight class D patients (\(P<0.001\)) (Table 1).

The preoperative differential laxity was 5.5 mm (range: 0–14 mm) and 1.1 mm at the final follow-up (0–4) (\(P<0.00001\)). Preoperatively the pivot-shift was absent in 32 cases, trace in 67 cases, positive in 50 cases and gross in 19 cases. Postoperatively four patients had a trace pivot-shift and in one patient it was clearly positive (Table 2).

At the final follow-up 13% of the patients reported residual pain. This pain was statistically correlated to postoperative flexum (\(P<0.016\)) and the type of graft used (\(P<0.00018\)). Nine patients underwent revision surgery for anterior arthrolysis because of a cyclops syndrome and one patient due to a secondary lesion of the medial meniscus. Five patients (3%) presented with a graft failure.

**Discussion**

In this multicenter study, following confirmation of an intact PL bundle at arthroscopy an isolated ACL reconstruction of the AM bundle was performed. Determination of the
Table 1  Comparison of pre- and postoperative subjective and objective IKDC scores and the Lysholm scores.

<table>
<thead>
<tr>
<th></th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjective IKDC (points)</td>
<td>63.7</td>
<td>90.5</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Objective IKDC (patients)</td>
<td>1</td>
<td>114</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>A</td>
<td>47</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>94</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>26</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Lysholm score</td>
<td>80</td>
<td>95.5</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Table 2  Results of pre- and postoperative instrumental measurement of laxity, and manual measurement of pivot-shift.

<table>
<thead>
<tr>
<th></th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean anterior laxity (mm)</td>
<td>5.5</td>
<td>1.1</td>
<td>&lt;0.00001</td>
</tr>
<tr>
<td>Pivot-shift test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 0 (absent)</td>
<td>32</td>
<td>163</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Grade I (trace)</td>
<td>67</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Grade II (positive)</td>
<td>50</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Grade III (gross)</td>
<td>19</td>
<td>0</td>
<td></td>
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</table>

mechanical or histological properties of the intact PL bundle was not performed. Partial ACL reconstruction with preservation of selective bundles has already been evaluated in several studies [6–10]. Nevertheless to our knowledge this is the largest series of operated patients to date. For those who support this approach, isolated reconstruction of the injured bundle of the ACL optimizes the biological process of healing and graft integration [6,11,17–21] as well as optimizing stability [22] and postoperative proprioceptive control [23–28].

Our study indicates that a partial tear is suggested when the preoperative clinical assessment shows a Lachman test with a delayed firm end point associated with a glide pivot-shift. Although this idea was already reported during the 2007 SFA symposium [29], confirmation of a torn ACL bundle is not enough. Moreover, this does not provide information on the quality of the remaining native ACL. In our study, pivot-shift test results were statistically correlated to differential laxity and seemed to increase with the delay between the accident and surgery suggesting that rotational laxity deteriorates over time.

Differential preoperative laxity measured by the KT1000 arthrometer or the Telos® stress device were lower than that observed in complete tears [29,30] but higher than that published in partial tears [8,30]. Finally, in addition to these tests, the diagnosis was always confirmed by exploratory arthroscopy as recommended by most authors [6–10,12,31,32]. A significant number of meniscal and chondral lesions were also identified during this exploratory arthroscopy at rates similar to those found in complete tears [29,30]. Nevertheless, none of these lesions were correlated to the injury/surgery delay, to the degree of laxity or to pivot-shift results. Therefore they seem to be associated with the injury but did not worsen over time in this series because the injury/surgery delay was short. The types of grafts used and the femoral tunnel technique did not influence the final laxity results. The subjective and objective results as well as the postoperative laxity assessment were good and similar to those found in other published studies [6–10]. At the final follow-up the rate of complications and the percentage of recurrent tears was low (3%). However, more than 10% of the patients had residual pain, especially anterior. This pain was statistically correlated to persistent postoperative loss of full extension. Most cases of secondary revision were performed due to an anterior cyclops syndrome, which was strongly correlated to the type of graft. In most cases, these were partial reconstructions with a normal sized patellar tendon graft (10 mm). This has already been mentioned in another series [10]. Irrespective of the type of graft it seems to be very important to reduce the diameter of the graft compared to classic reconstruction to avoid excess tissue in the intercondylar notch which can cause the triad of large graft-loss of full extension-pain. Certain authors recommend that the graft should be more than 7–8 mm in diameter [8,10].

Our study has certain limitations. It is a retrospective multicenter study with different reconstruction and graft techniques, and with laxity measurement by radiograph (Telos) and arthrometer (Rolimeter and KT 1000). Although the results of laxity measurements are close with these differing techniques the results would have been more homogeneous if we had used a single technique. The surgeon’s decision to perform selective bundle reconstruction was based on arthroscopic assessment of the residual bundle, which can be criticized because it is based on individual interpretation. The principle of this technique is based on the preservation of native ACL fibers, which is impossible to quantify at the end of surgery. Moreover, we did not evaluate the postoperative MRI signal of our grafts, or compare them with a series of ACL reconstructions without preserved bundles. Nevertheless, the strength of this study is the large size of the patient group.
Conclusion

Our study in a large number of patients, confirms that irrespective of the graft or technique used, selective ACL reconstruction of the AM bundle with preservation of the PL bundle, restores knee stability and function. Special attention must be paid to the size of the graft used. A graft that is too large can result in postoperative loss of full extension and pain due to excess tissue in the intercondylar notch. It would be of interest to study the integration and healing of our grafts during these partial reconstructions and compare them to ACL reconstructions with no preservation of native fibers.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References


