Anterior cruciate ligament mucoid degeneration: Selecting the best treatment option

F. Lintz\textsuperscript{a,*}, N. Pujol\textsuperscript{a}, D. Dejour\textsuperscript{b}, P. Boisrenoult\textsuperscript{a}, P. Beaufils\textsuperscript{a}

\textsuperscript{a} Versailles Hospital Center, 177, Versailles Street, 78150 Le Chesnay, France
\textsuperscript{b} Sauvegarde Private Hospital, 480, Ben-Gourion avenue, 69009 Lyon, France

Accepted: 15 February 2010

Summary
Introduction: Mucoid degeneration of the anterior cruciate ligament (ACL) is a little-known entity. The clinical presentation is one of posterior pain with limited flexion. Its interstitial nature within the ACL structure contrasts with synovial cyst of the ACL. Arthroscopic treatment may include ACL resection, which raises the questions about the harmlessness of this procedure and the risk of anterior instability.

Hypothesis: Arthroscopic resection of ACL mucoid degeneration is effective for treating pain and flexion limitation, but at the expense of anterior laxity.

Patients and methods: This bicentric, retrospective cohort study with an average follow-up of 6 years involved 27 patients (29 knees) presenting with symptomatic ACL mucoid degeneration validated by magnetic resonance imaging (MRI). Noninfiltrating synovial cysts of the ACL were excluded. Average patient age was 49 (22 to 68) years. Preoperative assessment included a questionnaire, clinical examination (Lachman and pivot shift tests), MRI and standard radiography. Arthroscopic examination analyzed the ACL aspect and its associated lesions (meniscus, cartilage). Anatomopathology samples were collected in 18 cases. Postoperative follow-up included standard radiography and dynamic examination, measuring laxity with a Telos\textsuperscript{TM} device.

Results: Pain was posterior in 23 knees (80%). Fourteen knees (48%) had limited flexion, on average 97°. Twelve partial and 17 total resections were performed. Twenty knees (69%) had associated cartilaginous lesions and 19 (66%) had meniscal lesions. Meniscectomy was undertaken in 11 cases (41%). Posterior pain disappeared in 27 cases (93%), on average 3.7 weeks after the procedure. Average improvement in flexion was 21.5° (0 to 60°). Twenty-eight knees (97%) showed soft and/or delayed stops on postoperative Lachman testing. Average postoperative differential laxity on the Telos\textsuperscript{TM} device was 8.3 mm (5 to 13 mm). Average postoperative International Knee Documentation Committee (IKDC) and Knee Injury and Osteoarthritis Outcome

* Corresponding author. Tel.: +33 1 39 63 94 31; fax: +33 1 39 63 87 38.
E-mail address: francoislintz@gmail.com (F. Lintz).

1877-0568/$ - see front matter © 2010 Elsevier Masson SAS. All rights reserved.
doi:10.1016/j.otsr.2010.02.008

© 2019 Elsevier Masson SAS. Tous droits réservés. - Document téléchargé le 19/03/2019 Il est interdit et illégal de diffuser ce document.
Introduction

Mucoid degeneration of the anterior cruciate ligament (ACL) is a little-known pathology. This infiltrating lesion is included in the mucoid pathology of the intercondylar fossa. It contrasts with cystic lesions better known as synovial cysts or intercondylar fossa cysts. Its prevalence in magnetic resonance imaging (MRI) is 1.8 to 5.3% [1,2], but not all lesions are symptomatic. The normal clinical picture of symptomatic ACL mucoid degeneration is posterior knee pain with flexion limitation.

The published literature on this subject varies greatly, combining treatment of cystic and infiltrating lesions [1—12]. In many cases, co-existence of the two lesion types makes interpretation difficult. The study by Bergin et al. [2] helped to define differences on MRI and to distinguish infiltrating lesions, also known as mucoid hypertrophy [13], degeneration [14] or infiltrating ACL pseudocysts [15], from purely cystic lesions.

The proposed treatment may be lesion removal under arthroscopy. In case of mucoid degeneration, the procedure is partial or subtotal ACL resection.

The objective of our study was to analyze the semiological context of ACL mucoid degeneration and the outcome of treatment by partial or total arthroscopic ACL resection. Our hypothesis is that partial or total ACL resection improves pain symptoms and flexion limitation, but at the expense of residual anterior laxity. The hypothesis was tested by retrospective analysis of 29 cases.

Patients and methods

This bicentric retrospective cohort study, performed between 1999 and 2009, involved 29 knees (27 patients). Patient files were reviewed by an observer who did not participate in the procedures. Inclusion criteria were symptomatic ACL mucoid degeneration validated by MRI according to diagnostic criteria defined by Bergin et al. [2]: overall hypersignal of the ACL in T1-T2, increased overall ACL volume, ligament fibres clearly seen in T2, continuous tibial to femoral insertion. Excluded were patients who had a distinctive cystic lesion without ACL hypertrophy (synovial cyst, intercondylar fossa cyst or ACL cyst). MRI also made it possible to measure ACL hypertrophy or notch stenosis. These measures were compared by Student’s t test with control values published by Cha et al. [13], specifically sagittal notch angle (SNA), which measures the narrowness of the notch in the sagittal plane. We added a ratio to it, comparing ACL size to the notch and the ACL index whose normal value (0.23) is calculated on the basis of control group data provided by Cha et al. [13]. Standard radiographic examination in monopodal stance showed the presence of possible osteoarthritis according to the Ahlbck classification.

There were 19 men and eight women (sex ratio 2:2). Average age at the time of diagnosis was 49.3 (22 to 68) years. Two patients had a bilateral form. The type of activity performed was: physically active, eight patients (30%); moderately active, 11 patients (40%); and sedentary, eight patients (30%). Preoperatively, 13 patients (48%) practised an in-line sport, seven patients (26%), a pivoting sport, and seven patients (26%), no sport. Seven (26%) were sometimes involved in competitive sports, 15 (55%) in regular leisure activities, and five (19%) in occasional leisure activities.

We examined the medical histories of the injured knee, the time period between the onset of pain and development mode, the concept of initial trauma, the pain location, anterior translation at the Lachman manoeuvre, and articular amplitudes. The average duration of symptoms before consultation was 15.5 months (1 to 120 months). In nine patients (31%), an authenticated trauma was correlated with the onset of symptoms. Pain had a posterior component in 23 cases (80%), purely posterior in the popliteal cavity in two out of three cases, associated with medial pain in 27% of cases, anterior in 10% of cases. In one case, pain was lateral, and in the other two, central. Ten patients had already undergone a surgical procedure: eight medial meniscectomies, one lateral meniscectomy, and one arthroscopy for the removal of foreign bodies. Six of the meniscal lesions were of the degenerative type. These procedures were conducted on average 8.6 years (0.25 to 24 years) before the ACL index surgery. In three cases, the ACL was described as normal. Failure of the meniscectomy led to reconsideration of the diagnosis. Fourteen knees (48%) had a loss of flexion (average flexion 97° [50 to 130°]). The preoperative Lachman test was a hard stop in 28 cases and a delayed hard stop in one case.

All patients had been operated under arthroscopic control. The diagnosis of mucoid degeneration, initially established on MRI, was supported by a description of the ACL aspect corresponding to the arthroscopic diagnostic criteria enumerated by McIntyre et al. [9]: continuous ACL fibres, increased ACL volume, yellowish-coloured material expressed on palpation, loss of ACL synovial lining. The ACL procedure was performed à la carte: partial resection (resection of less than 50% of thickness) when it was possible to preserve part of the ACL after removal of the lesion or total resection (over 50%) of the ACL with a motorized resector, and plasty on the notch when a conflict was noted with the notch (axial view of the lateral condyle). Biopsy was performed for anatomopathology study in 18 cases (62%). Weight-bearing with free mobility was authorized in the immediate postoperative period.

Scores (KOOS) were 71.2 (42.5 to 92.0) and 78.2 (26.4 to 99). Two patients underwent secondary ligamentoplasty.

Discussion: Treatment of ACL mucoid degeneration by arthroscopic resection is effective for posterior pain and flexion limitation. It results in postoperative laxity, but rarely in frank instability. Therefore, indications for ACL resection must be carefully selected. Young and active patients should be warned about the risk of requiring secondary ligamentoplasty.

Level of evidence: IV (retrospective cohort study).
The average follow-up was 6 years (1 to 10 years). Postoperative assessment included a clinical and standard radiographic examination in monopodal and dynamic stance (Telos™ to 15 kg). Functional state was assessed by subjective International Knee Documentation Committee (IKDC) [16] and Knee Injury and Osteoarthritis Outcome Score (KOOS) [17] questionnaires (by telephone for 10 patients). Quantitative and qualitative variables were compared statistically with Instat 3.0 software; Student’s paired t tests were used. The statistical significance threshold chosen was 5%.

**Results**

**Imaging**

On MRI, all patients presented the criteria of ACL degeneration described by Bergin et al. [2] (Fig. 1). This aspect could be compared to a "celery stalk sign" noted by some authors [6,7,18], which reflects the dissociation of ACL fibres by mucoid material. Five hypersignals, which could indicate bone cysts at the tibial attachment and one at the femoral attachment, were observed. Notch measurements in our patients showed significantly increased ACL volume and narrow notches: ACL index = 0.58, \( P < 0.001 \) (normal = 0.23 according to Cha et al. [13]) and SNA = 31.2°, \( P < 0.001 \) (normal = 39.1° according to Cha et al. [13]).

**Arthroscopy**

In all cases, arthroscopy revealed the ACL either as diffusely hypertrophic, but particularly in the proximal part in six cases, yellowish- or brownish-coloured, taut and bulging in the notch (Fig. 2). The ACL presented fibres without synovial lining, shiny in appearance, dilacerated. In one case, the very distinctive anteromedial bundle was the only one affected. In another case, it was the posterolateral bundle pressing the anteromedial bundle towards the front that was causing a conflict between it and the notch. In one case, the ACL lesion was associated with an extraligamentous mucoid cyst of the intercondylar fossa.

Twelve partial ACL resections (Fig. 3) and 17 total or subtotal resections were undertaken. Two intercondylar...
notch enlargement procedures were performed. Sixteen degenerative lesions of the medial meniscus (55%) and five of the lateral meniscus (17%) were noted. Nine medial and two lateral meniscectomies were done at the same time. Thirteen femoro-patellar cartilaginous lesions (45%), 13 (45%) medial femoro-tibial lesions (six grade 1, five grade 2, two grade 3) and six (21%) lateral femoro-tibial lesions (two grade 1, four grade 2) were observed. Nine knees (31%) did not present any cartilaginous lesion.

**Histology**

In all 18 cases that had histological examination, anatomopathology confirmed the diagnosis of ACL mucoid degeneration with the presence of a diffuse or microcystic mucoid substance penetrating into collagen fibres and dissociating them (Fig. 4). Chondroid transformation was noted in 1 case, and neovascularization in two cases. The absence of inflammatory processes was apparent in two cases. The synovia was specifically implicated in five cases, described as atrophic three times, hyperplasic once, and inflammatory once.

**Postoperative clinical results**

Average follow-up was 6 years (1 to 10 years). A 61-year-old patient presenting with a bilateral form also developed infectious arthritis due to *staphylococcus aureus*, which was treated by antibiotic therapy and arthroscopic lavage. There was no recurrence after a follow-up of over 5 years.

Postoperative flexion improvement was on average 21.52° (0 to 60°). Posterior pain disappeared in 93% of cases (27 knees). On the other hand, in cases where it was associated with anterior, medial or lateral pain, the associated component persisted. The average duration of recovery (disappearance of pain and potential resumption of sports activity) was 3.7 weeks (0 to 10 weeks).

In the postoperative period, the number of patients with instability ranged from 4 (at 6 months postoperatively) to 14 during the longest follow-up. They were all less than 50 years old and exercised regularly and intensely, either recreationally or as part of a professional activity. All knees (n = 29) examined pre-operatively (Fig. 5) presented a Lachman hard stop without pivot shift. The knees examined postoperatively showed a positive Lachman soft stop (16 cases) or delayed hard stop (two cases). Eight clear pivot shifts were noted at follow-up.

Telos™ dynamic radiography examination showed average differential anterior laxity of 8 mm (5 to 13 mm, \(P < 0.001\)). Two unstable patients (aged 33 and 35 years, respectively) had their ACL reconstructed within 2 to 5 postoperative years. Three secondary meniscectomies were performed at 20 months (12 to 24): two medial, one lateral. Two patients (aged 55 and 64 years respectively) had total knee arthroplasty at 2 and 5 years. They presented major

---

**Figure 4** Pathology samples. a: normal anterior cruciate ligament (longitudinal fibers, clearly visible nuclei); b: loss of normal architecture with presence of mucoid substance (violet, collagen is pink); c: alcian blue staining (mucoid substance in blue, collagen in gray); d: Masson’s trichrome staining (collagen fibers green, mucoid substance transparent).

**Figure 5** Postoperative evolution of anterior laxity (percentage).
<table>
<thead>
<tr>
<th>Author</th>
<th>Number of cases</th>
<th>Age</th>
<th>Sex</th>
<th>Initial trauma</th>
<th>Instability</th>
<th>ACL resection</th>
<th>Pain centre</th>
<th>Mobility</th>
<th>MRI diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Preoperative</td>
<td>Follow-up</td>
<td>Partial</td>
<td>Total</td>
<td>Preoperative</td>
</tr>
<tr>
<td>Nishimori et al. [3]</td>
<td>2</td>
<td>45</td>
<td>F</td>
<td>—</td>
<td>—</td>
<td>+</td>
<td>—</td>
<td>Post</td>
<td>0-0-120</td>
</tr>
<tr>
<td>Fealy et al. [4]</td>
<td>1</td>
<td>38</td>
<td>F</td>
<td>+ Hyper-extension</td>
<td>—</td>
<td>50%</td>
<td>—</td>
<td>—</td>
<td>Post</td>
</tr>
<tr>
<td>Hensen et al. [6]</td>
<td>1</td>
<td>50</td>
<td>M</td>
<td>—</td>
<td>—</td>
<td>50% (PL)</td>
<td>—</td>
<td>Post</td>
<td>Limited flexion</td>
</tr>
<tr>
<td>Hsu et al. [7]</td>
<td>2</td>
<td>51</td>
<td>M</td>
<td>—</td>
<td>—</td>
<td>+</td>
<td>—</td>
<td>—</td>
<td>?</td>
</tr>
<tr>
<td>Kumar et al. [14]</td>
<td>1</td>
<td>35</td>
<td>M</td>
<td>+ Anterior trauma</td>
<td>—</td>
<td>—</td>
<td>+</td>
<td>Post</td>
<td>0-0-100</td>
</tr>
<tr>
<td>Robert [15]</td>
<td>8</td>
<td>53</td>
<td>7 M, 1 F</td>
<td>—</td>
<td>—</td>
<td>+</td>
<td>—</td>
<td>Post</td>
<td>0-0-100</td>
</tr>
</tbody>
</table>

associated cartilaginous lesions during the treatment of ACL mucoid degeneration.

The average postoperative IKDC score was 71 points (42 to 92). At follow-up, the results were good or very good in two thirds of the cases. The average postoperative KOOS score was 78 points (26 to 99) (pain, 83 points; symptoms, 82 points; daily life, 86 points; sports, 64 points; quality of life, 81 points). Factors of a poor prognosis included the presence of preoperative meniscal and cartilaginous lesions ($P < 0.01$) and age over 50 years ($P < 0.05$).

**Discussion**

Arthroscopic resection of ACL mucoid degeneration leads to rapid improvement of posterior pain and of flexion limitation, but at the expense of almost constant clinical laxity, which may become symptomatic with a risk of instability.

A review of the literature on the subject reveals many clinical cases and short heterogeneous series (Table 1). Even the term mucoid degeneration is used irregularly and is easily confused with cystic lesions. Degenerative mucoid lesion would be more explicit. The weaknesses of our study include the frequency of operations performed beforehand that negatively affect the final result, the presence of meniscal and associated degenerative cartilaginous lesions as well as the frequency of associated procedures that may influence the results.

ACL mucoid degeneration is not an uncommon pathology, but is often unknown. According to Bergin et al. [2] and Salvati et al. [1], it should be present in 2 and 5%, respectively, of knee MRIs in current practice and most often affects men between 40 and 50 years old. In practice and in the literature, it is often confused with a diagnosis of partial ACL rupture.

The concept of an initial trauma found in our study in one out of three patients is questionable. Some authors [19], among them McIntyre et al. [9], observed it in seven out of 10 patients, but others [2,12] did not report any at all. It becomes apparent in two subpopulations of patients. The first group is younger, active, athletic, in whom we can assume an ACL mechanism affected by real trauma or repeated microtraumas causing an early lesion. The second group is older and presents with progressive degenerative ACL lesions, with frequent concomitant degenerative meniscal lesions.

The clinical presentation is most often stereotypical. This pain is frequently posterior (80%), in the popliteal cavity, progressive, worsening with time, and frequently (50%) associated with flexion limitation around 100°. For Kumar et al. [14] and Hensen et al. [6], the pain is attributable to the effect of the ACL mass in the posterior notch. Hsu et al. [7] and Kim et al. [20] attribute it to incarceration of the pathological ACL in the posterior femoro-tibial compartment. In some cases [15], the clinical presentation is not typical or is associated with pains in the medial, lateral or femoropatellar compartments (one third cases in our study) related to frequent meniscal and cartilaginous lesions [20].

In our study, no recurrence was observed in over 5 years of follow-up, even in partial resections. As Robert [15] and Kim et al. [20] recommend, partial resection on demand seems possible to limit the induced laxity.

Our clinical results confirm those in the literature. Robert [15] studied the functional quality of degenerative ACL in the preoperative period, with KT 1000™, and reported that these knees were stable. This concept is confirmed here in the preoperative period with 93% of Lachman tests showing a hard stop, but objective postoperative Telos™ measurements disclose almost systematic laxity after partial or total ACL resection. Another notion addressed by this work is that of secondary instability. It is mentioned elsewhere only by McIntyre et al. [9] who reported one case of atraumatic ACL rupture at 1 postoperative year after partial resection. Our results indicate that postoperative laxity, largely asymptomatic, can increase anterior laxity over time and evoke instability. In two of our patients (7%), ACL reconstruction was later necessary.

**Conclusion**

Arthroscopic resection of symptomatic degenerative ACLs gives good subjective results, but leads to progressive postoperative laxity. The prognosis depends on patient age and associated lesions. The diagnosis of ACL mucoid degeneration must be suspected with unusual posterior pain and flexion limitation. MRI and arthroscopy confirm the diagnosis. Lack of diagnostic knowledge can result in a number of superfluous meniscectomies that impact the final result. The lack of recurrence speaks in favour of à la carte resection, the most partial possible, especially when patients are without associated degenerative lesions. More active patients should be forewarned about the risk of postoperative instability.

**Conflict of interest**

None.

**References**