Analysis of meniscal lesions accompanying anterior cruciate ligament tears
Lésions méniscales constatées lors de la reconstruction du ligament croisé antérieur


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ABSTRACT

Purpose of the study
The purpose of this retrospective study of a continuous series was to document preferential types and locations of meniscal lesions accompanying anterior cruciate ligament tears and to demonstrate the relationships between meniscal lesions, patient age, and time from trauma to surgery.

Material and methods
One hundred fifty-six patients with no history of meniscal lesions underwent ligamentoplasty in 2003. All procedures were performed by the same operator. The time from trauma to surgery was 31.6 months on average. This was a retrospective continuous series using data from detailed operative reports.
Results
An isolated lesion of the medial meniscus was observed in 25.6% of cases. There was an isolated lesion of the lateral meniscus in 21.8% and lesions of both menisci in 9%. The most frequent injury was a longitudinal fissuration, for both menisci. Patient age and time from trauma to surgery were statistically correlated with presence of a medial lesion. There was no statistical relationship for the lateral meniscus nor for the type of meniscal injury.

Discussion
The proportion of lesions to the lateral meniscus appeared to be unaffected by age or time to surgery after trauma, suggesting that lateral meniscal lesions occurred at the time of the initial cruciate injury. On the contrary, the incidence of medial lesions increased with time and patient age, confirming the important role of the medial meniscus to block anterior displacement of the knee. We therefore recommend early repair of anterior cruciate ligament tears in order to avoid medial meniscectomy, which may multiply with increasing time from injury to surgery and thus affect the postoperative outcome.

Key words: Anterior cruciate ligament, meniscal tear, ligament reconstruction.

INTRODUCTION
The development of sports activities in our society has contributed to the increase in anterior cruciate ligament injuries. The associated meniscus lesions have been frequently studied. Most of these studies show a predominance of lateral lesions at the acute stage [Binfield et al. (1), Cipolla et al. (2), Nikolic (3), Wickiewicz (4)], but other others report a predominance of medial lesions [Cerabona et al. (5), Keene et al. (6), Paletta et al. (7)].

The presence of meniscal lesions stemming from anterior cruciate ligament tear can be explained by several mechanisms. The meniscus can be injured simultaneously with the ligament or the meniscus lesion can be secondary to the ligament injury. The natural history of chronic anterior laxities was studied by Dejour et al. (8) and Imbert (9). The lateral tibial surface acquires an abnormal pivot mobility, and the abnormal stresses on the medial and lateral compartments thus cause meniscal injury. Medial meniscectomy aggravates anterior subluxation of the tibial surface and encourages lateral dislocation, which increases the stresses causing varus. This favors cartilage lesions and finally arthrosis [Gillquist and Messner (10)].

The objective of this continuous retrospective study on 156 ligament reconstructions of the anterior cruciate ligament was to document the preferential types and locations of the meniscus lesions accompanying ligament injuries. We also sought to demonstrate any relations between time from trauma to surgery, age, and different lesion characteristics.

MATERIAL AND METHODS
Inclusion criteria
Patients with a history of surgery on the same knee were excluded from the study because the origin and date of meniscal lesions was too uncertain in cases of earlier meniscectomy or in cases of a second ligamentoplasty. Therefore, 156 patients were included in this study out of 176 patients operated on for ACL reconstruction in 2003 by a single senior operator (BM) using the blind tunnel arthroscopic technique.

Presentation of the patient series
The patient series included 45 women and 111 men. There were 76 right knees and 80 left knees. The age at surgery was 29.4 ± 10 years (range, 14-57 years).

One hundred sixteen patients (74.3%) were under 35 years of age (fig 1). The time from trauma to surgery was a mean 31.6 ± 59.7 months, ranging from 1 week to 30 years (fig 2). Ninety-one patients (58.3%) were operated on in the year following injury. Only four patients were operated on in the first month following the accident. In four cases, it was not possible to determine this time lapse, because when questioned the patient could not specify a particular incident causing the injury. The cause of injury was found in 97.4% of cases, a sports accident in 89% of cases. The sports involved were most often pivot sports, in particular soccer and skiing. Ball sports, other than soccer, accounted for approximately 20%.

Methodology
The patients’ medical charts were used to collect data on the history of the injury and the detailed surgery report. The time from trauma to surgery was noted in months rather than days to reduce the risk of errors with long delays before surgery. Several parameters were noted and analyzed: the presence of meniscal lesions (medial, lateral, or both), the type of meniscal lesion (longitudinal, radial, flap, horizontal, bucket handle tear or complex lesion), and the meniscus lesion location (anterior, middle, or posterior). We called “bucket handle” lesions longitudinal tears that were long enough to be susceptible to luxation in the femoral notch. We also noted the measurements of laxity taken with Daniel’s KT-1000 arthrometer before surgery. Three measurements were taken on the knee: KT1 (7 kg of traction), KT2 (9 kg of traction), and KTmax (maximum manual traction). The differential measurement retained was the greatest injured knee/healthy knee difference.
Data for each patient were collected and entered in an Excel 2000 spreadsheet. A descriptive analysis of all the parameters measured was done, using the means plus standard deviation and frequency distributions. Individual data were then treated using SPSS version 11.0 software for Windows (SPSS Inc., Chicago, IL, USA). A descriptive univariate analysis on the study’s population was done. The relations between certain characteristics (time from trauma to surgery, age) and the parameters noted were studied. The Student \( t \) test (after having verified the Gaussian distribution and the squared variance) was used for quantitative variables and Pearson’s chi square test or Fisher’s exact test was used for categorical variables. The analysis of variance (ANOVA) was used to compare the quantitative and qualitative data.

RESULTS

Meniscus lesions

Eighty-four patients (56.4%) had at least one meniscus injury: 25.6% presented an isolated medial meniscus lesion, 21.8% an isolated lateral meniscus lesion, and 9% lesions in both menisci. The most frequently found lesion of the medial meniscus was a longitudinal fissure of the posterior segment (44%). We found no radial lesions of the medial meniscus. In addition, 16% of the lesions found were bucket handle lesions.

The most frequently found lesion of the lateral meniscus was a longitudinal tear of the posterior segment (37%). There was nonetheless a higher proportion of radial and flap lesions than in medial lesions. In addition, we found 6% bucket handle lesions (table I).

The posterior segment was involved in 98.2% of medial meniscus injuries and in 43.8% of lateral meniscus tears; 83.5% of the meniscus lesions only involved a single segment (table II).

Influence of trauma to surgery time

The mean time from trauma to surgery was statistically greater (\( p = 0.001 \)) for patients with a medial meniscal lesion (53.7 months ± 84.4) than for those with no medial meniscus injury (20.5 months ± 38).

The mean time from trauma to surgery was not statistically greater (\( p = 0.195 \)) for patients presenting a lateral meniscus injury (40.9 months ± 78) than for those with no lateral meniscus injury (27.4 months ± 48.8).

<table>
<thead>
<tr>
<th>Table I. – Types of meniscal injuries</th>
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<table>
<thead>
<tr>
<th>Lesion</th>
<th>Medial meniscus</th>
<th>Lateral meniscus</th>
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</thead>
<tbody>
<tr>
<td>Longitudinal tear</td>
<td>44%</td>
<td>37%</td>
</tr>
<tr>
<td>Bucket handle</td>
<td>16%</td>
<td>6%</td>
</tr>
<tr>
<td>Radial tear</td>
<td>0%</td>
<td>23%</td>
</tr>
<tr>
<td>Flap</td>
<td>20%</td>
<td>19%</td>
</tr>
<tr>
<td>Horizontal tear</td>
<td>9%</td>
<td>13%</td>
</tr>
<tr>
<td>Complex tear</td>
<td>11%</td>
<td>2%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
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<tr>
<th>Table II. – Location of meniscus injuries</th>
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<table>
<thead>
<tr>
<th>Segment</th>
<th>Medial meniscus</th>
<th>Lateral meniscus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior segment</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Middle segment</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>Posterior segment</td>
<td>49</td>
<td>21</td>
</tr>
<tr>
<td>At least two segments</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>
The proportion of medial meniscus tears increased with time from trauma to surgery, increasing more after the 5th year, which was statistically significant. The proportion of lateral meniscus lesions seemed to remain relatively stable over time (fig 3).

Influence of age

The mean age of patients was statistically higher \((p = 0.001)\) in patients presenting a medial meniscus lesion \((33 \text{ years} \pm 11)\) than for patients with no medial meniscus lesion \((27.6 \text{ years} \pm 9.1)\). The mean age of patients was not statistically different \((p = 0.551)\) in patients presenting a lateral meniscus lesion \((28.6 \text{ years} \pm 9.9)\) and in patients with no lateral meniscus lesion \((29.8 \text{ years} \pm 10.3)\).

In patients under 30 years of age, the lateral meniscus was injured the most often. In patients over 30 years of age, the medial meniscus was the most frequently involved (table III).

Patients presenting a meniscal flap and those presenting a complex lesion of the medial meniscus were older, but the difference was not statistically significant. No statistically significant relation was demonstrated between age and type of meniscal lesion. In absolute values, a single complex lesion was found on the lateral meniscus. For the different lesions, the mean age seemed homogenous.

It should be noted that there was no correlation between age and time from trauma to surgery. These were two independent factors.

Influence of laxity

The mean KT1 was \(7.4 \text{ mm} \pm 1.8\) (range, 4-14 mm). The mean KT2 was \(9.5 \text{ mm} \pm 1.9\) (range, 5-15 mm). The mean Ktmax was \(15.5 \text{ mm} \pm 2.7\) (range, 6-22 mm). The mean differential was \(7.2 \text{ mm} \pm 2.8\) (range, 0-14 mm).

We found no correlation between the extension of the laxity and whether or not there was a medial or lateral meniscus lesion.

DISCUSSION

Our study could be criticized for one methodological issue. This was a case study and not a longitudinal study. Patients were recruited most often long after the accident, making it difficult to have an early MRI for each patient. Certain meniscal lesions indeed can heal spontaneously. This may have led us to underestimate the number of initial meniscus injuries.

Several studies have analyzed the progression of meniscal lesions with chronic ACL laxity. In a prospective study investigating 575 unstable knees, Smith and Barrett (11) found nearly as many medial as lateral meniscus injuries. The most frequently found lesion was a peripheral tear of the medial meniscus’s posterior segment. More than 56.4% of our study’s patients has a meniscus lesion, quite close to the rate found in other series: 72.8% for Tandogan et al. (12), 65% for Seitz et al. (13), and 59% for Binfield et al. (1). The proportion of medial and lateral meniscus lesions is comparable in these studies. We found 25.6% medial lesions and 21.8% lateral lesions (table IV).

The history of meniscus injuries seems to be different depending on whether they are lateral or medial. We found a statistically significant increase in medial meniscus lesions with increasing time from trauma to surgery, whereas the proportion of lateral meniscus injuries was stable, in agreement with the literature. In a series of
ACL lesion beyond 120°. Recent study, Williams and Logan (15) showed that in an acute-stage medial meniscus lesions, and time from injury to surgery, as we also found. On the contrary, Cerabona et al. (5) found a greater proportion of medial injuries in acute situations. In our study, lateral meniscal lesions were more numerous at the beginning of progression; after 5 years from injury to surgery, the curves invert and the proportion of medial meniscus lesions increases. Cipolla et al. (2) found 31% acute-stage medial meniscus lesions versus 70% chronic lesions.

Lateral meniscus injuries occur for the most part upon injury during a mechanism of valgus flexion and lateral rotation, the main mechanism coming into play in ACL injuries. In addition, in an MRI study on fresh ACL lesions, Panisset et al. (14) noted the predominance of subchondral bone contusions on the knee’s lateral compartment. The most frequent lesion found was a contusion of the lateral condyle and the lateral tibial surface. On the pathological level, this corresponds to an impact between the anterior part of the lateral condyle and the posterior edge of the lateral tibial surface. The biomechanics of the medial meniscus is different from that of the lateral meniscus. In a recent study, Williams and Logan (15) showed that in an ACL lesion beyond 120° of flexion, the lateral condyle moves back abruptly. The medial condyle also moves back, whereas it moves forward when the cruciate ligament is intact: this explains the greater proportion of medial meniscus lesions over time. Mechanically, the lateral compartment is solicitied in tension, whereas the medial compartment works for the most part in compression [Fithian et al. (16)]. In compression, the meniscus and the cartilage are solicited identically. The lateral stresses in tension are absorbed nearly 100% by the meniscus, which explains the greater frequency of acute lateral meniscus lesions.

In chronic lesions, the posterior segment of the medial meniscus is a brake to anterior tibial translation. When rising, there is abrupt subluxation of the lateral tibial surface under the condyle, immediately followed by repositioning. Before the rising occurs, the condyle pushes off the tibial surface, which results in the development of a lever effect transmitted to the medial tibial compartment. This tends to subluxate the medial condyle backward and thus create medial meniscal lesions. Recently, a German biomechanical study [Von Eisenhart-Rothe et al. (17)] demonstrated an increase in medial femur condyle translation in unstable knees, whereas the meniscofemoral translation remained unchanged. This may explain the potential for injury to the posterior segment of the medial meniscus, in support of the data in the literature.

The most frequently found meniscal lesion was a longitudinal tear of the posterior segment [Keene et al. (18)], for both the medial meniscus and the lateral meniscus. However, there was a high proportion of radial lesions on the lateral meniscus. We were not able to demonstrate a statistical relation, probably because the patient sample was too small. In 764 patients, two studies, Tandogan et al. (12) and Cerabona et al. (5), noted a statistically higher proportion of radial lesions on the lateral meniscus. We found few complex lesions (2% lateral and 11% medial). This may very well originate from the relatively short time from injury to surgery. More than 75% of the patients operated on in 2003 were operated on within 2 years of their accident. The large number of lesions, both medial and lateral, probably results from the combination of several mechanisms: the complexity and diversity of the initial mechanisms of injury, on the one hand, and the time from injury to surgery, on the other hand. It would have been interesting to specify the meniscal zones where the tears were found (peripheral or central), since different zones do not have the same potential for healing, but the surgery report did not provide enough details for this analysis.

We were not able to demonstrate a correlation between the degree of laxity and the presence of meniscal lesions, even though this is noted in the literature [Baker et al. (19)].

Age was also related to the presence of medial meniscal damage, with a statistically significant relation. As for the type of lesion, in our study it seems that the proportion of complex lesions or meniscal flap lesions was greater in older patients. The small sample size for certain types of tears did not allow us to bring out a statistical relation (e.g., one complex tear of the lateral meniscus in the series). Tandogan et al. (12) found a statistically significant difference between age and the complexity of the medial meniscus injury, with age a predominating factor [Ross et al. (16)].

Table IV. – $X_{\text{AA}}$

<table>
<thead>
<tr>
<th></th>
<th>Number of patients</th>
<th>Mean time to surgery (months)</th>
<th>Meniscus injuries (%)</th>
<th>Lateral meniscus injuries (%)</th>
<th>Medial meniscus injuries (%)</th>
<th>Injuries to both menisci (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binfield 1993 (1)</td>
<td>400</td>
<td>23.3</td>
<td>58.6</td>
<td>30.3</td>
<td>21.3</td>
<td>7</td>
</tr>
<tr>
<td>Tandogan 2004 (12)</td>
<td>764</td>
<td>19.8</td>
<td>72.8</td>
<td>16</td>
<td>37</td>
<td>20</td>
</tr>
<tr>
<td>Our series</td>
<td>156</td>
<td>31.6</td>
<td>56.4</td>
<td>21.8</td>
<td>25.6</td>
<td>9</td>
</tr>
</tbody>
</table>

333 patients presenting fresh injury (< 15 days), Cipolla et al. (2) found 31% medial meniscus lesions and 51% lateral injuries. Nikolic (3) reported 72% lateral meniscus lesions, and no statistical relation was found between lateral meniscus lesions and time from injury to surgery, as we also found. On the contrary, Cerabona et al. (5) found a greater proportion of medial injuries in acute situations. In our study, lateral meniscal lesions were more numerous at the beginning of progression; after 5 years from injury to surgery, the curves invert and the proportion of medial meniscus lesions increases. Cipolla et al. (2) found 31% acute-stage medial meniscus lesions versus 70% chronic lesions.
et al. (20)]. A statistical relation was established in our study for medial meniscus injuries. There was a very clear inversion of the curves, highlighting the high proportion of lateral meniscus injuries in young subjects, whereas in subjects over the age of 30, medial meniscus lesions predominated.

From a therapeutic point of view, these results encourage early surgery [Seitz et al. (13)], which would make it possible to preserve the meniscus stock. Keene et al. (18) estimate that 80% of acute medial meniscal tears are repairable, whereas it was estimated that 46% of chronic tears could be repaired. The results of ligamentoplasty in terms of instability and arthritis progression are less promising in cases of meniscectomy, even partial [Gillquist and Messner (10)]. Acute lateral meniscus tears have a high potential for healing because they are often located in a vascularized peripheral zone [Arnoczky and Warren (21)]. Therefore, retaining the meniscus stock should be preferred, and even more so for the lateral meniscus [Hulet et al. (22)], Pierre et al. (23)], because of their demonstrated role in the biomechanics of the knee [Fairbank (24), Walker and Erkan (25)]. Furthermore, this is a prognostic factor for residual laxity [Laffargue et al. (26)].

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