Original article

Long-term assessment of meniscal extrusion after meniscal repair

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Extrusion
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Abstract

Background: Arthroscopic meniscal repair limits the medium-term risk of radiological osteoarthritis. Magnetic resonance imaging (MRI) cannot provide an accurate assessment of meniscal healing but may show harbingers of osteoarthritis such as meniscal extrusion. The objective of this study was to assess long-term meniscal extrusion after meniscal repair.

Hypothesis: Arthroscopic meniscal suture is not followed by meniscal extrusion and can, therefore, provide good knee function in the long-term.

Methods: Consecutive patients who underwent arthroscopic meniscal suture on a stable or stabilised knee were included retrospectively. MRI was performed to measure absolute meniscal extrusion (AME), relative meniscal extrusion (RME), anterior sagittal extrusion (ASE), posterior sagittal extrusion (PSE), coronal cartilage coverage index (cCCI), and sagittal cartilage coverage index (sCCI).

Results: After a mean follow-up of 8.8 ± 0.87 years, there was no evidence of meniscal extrusion in these patients with stable or stabilised knees: AME, 1.7 ± 1.03 and 2.3 ± 0.93 mm, RME, 17 ± 0.10% and 28 ± 0.12%, ASE, 2.52 ± 1.43 and 1.71 ± 2.42 mm, PSE, 0.29 ± 0.49 and 0.22 ± 2.35 mm, cCCI, 23 ± 0.08% and 20 ± 0.09%, and sCCI, 49 ± 0.10% and 53 ± 0.09%.

Conclusion: In the long-term after meniscal repair, osteoarthritis is limited and meniscal function seems preserved.

Level of evidence: IV, retrospective study.

1. Introduction

Meniscal repair is indicated to treat trauma-related injuries to the peripheral meniscus with either a stable knee or a tear in the anterior cruciate ligament (ACL). Meniscal preservation aims to prevent the development of knee osteoarthritis [1]. Arthroscopic meniscal repair has been shown to limit the development of osteoarthritis in the medium-term [2]. However, follow-up did not exceed 10 years in most studies, and osteoarthritis may occur only after a longer interval.

Meniscal extrusion is defined as extension of the meniscal margin by at least 3 mm beyond the tibial margin [3]. Meniscal extrusion is strongly associated with cartilage damage [4], may herald the development of osteoarthritis, and may be related to impaired meniscal function [5–7].

Magnetic resonance imaging (MRI) fails to accurately assess meniscal healing [8], as persistent high signal of unclear meaning is common even 10 years after meniscal repair. However, MRI may detect indirect evidence or harbingers of osteoarthritis, such as meniscal extrusion and subchondral bone oedema.

The objective of this study was to evaluate the frequency of meniscal extrusion 10 years after meniscal repair on stable or stabilised knees. The working hypothesis was that meniscal extrusion is rare after meniscal repair, indicating that the procedure exerts a lasting chondroprotective effect.

2. Material and methods

Patients who underwent arthroscopic meniscal repair between January 2005 and May 2009 were included in a retrospective study. Inclusion criteria were age older than 18 years or parental consent for younger patients, meniscal lesion confirmed by arthroscopy, stable or stabilised knee, and follow-up of 6 years or more. Exclusion criteria were age older than 50 years, tears in multiple ligaments, osteoarthritis grade 3 or higher in the Ahlbback classification, and degenerative meniscal lesions.
Ligament reconstruction was performed in patients with ACL tears, who were included in the stabilised-knee group. A bone-patellar tendon-bone or semi-tendinosus/gracilis (STG) graft was harvested from the same knee. Patients whose ACL was intact were classified in the stable-knee group.

The following variables were collected before and after surgery for each patient, age, knee alignment, constitutional ligament laxity, joint motion range, IKDC score, and type of ACL reconstruction in the stabilised-knee group. The arthroscopic features of the meniscal lesion were recorded: side, type, length, number of sutures, and distance from the meniscal margin.

MRI was performed at last follow-up using the PACS system (Picture Archiving and Communication System Centricity, General Electric, Milwaukee, WI, USA). T2-weighted images were obtained. The coronal slice through the centre of the femoro-tibial compartment was used to measure absolute meniscal extrusion (AME) [9] as the extension in millimetres of the meniscal margin beyond the tibial plateau margin, without taking osteophytes into account (Fig. 1). On the same slice, relative meniscal extrusion (RME) or percentage of extruded meniscus was determined as the ratio of AME over total meniscus size in the coronal plane [10,11] (Fig. 1). The sagittal slice through the centre of the femoro-tibial compartment was identified by counting the total number of slices through the compartment and selecting the middle slice. This middle slice served to measure anterior sagittal extrusion (ASE) as the distance between the anterior meniscal margin and anterior tibial cartilage margin and posterior sagittal extrusion (PSE) as the distance between the posterior meniscal margin and posterior tibial cartilage margin [12] (Figs. 2 and 3). The same coronal and sagittal slices were used to measure the coronal cartilage coverage index (cCCI) and sagittal cartilage coverage index (sCCI) as the percentage of tibial cartilage covered by the meniscus (i.e., the ratio of tibial cartilage covered by the meniscus over total tibial cartilage) (Fig. 4). The intra-observer and inter-observer reproducibility of these measures has been assessed previously [13].

Statistical analysis: quantitative variables were described as the median and range or interquartile range (IQR) depending on the parameters selected to report the results. Qualitative variables were described as n (%).

The clinical study variables in the stable-knee and stabilised-knee groups were compared by univariate analysis using the Mann-Whitney test or Chi² test or Fisher’s exact test, as appropriate. SAS 9.4 software (SAS Institute, Cary, NC, USA) was used for the statistical analyses. Values of P < 0.05 were considered significant.

3. Results

Of the 31 included patients, 11 had stable knees and 20 stabilised knees (patellar tendon graft in 15 and STG graft in 5). Mean age at surgery was 21 years (13–45) in the stable-knee group and 27 years (9–49) in the stabilised-knee group. Before surgery, radiological evidence of osteoarthritis was visible in a single patient (in the stabilised-knee group). Varus malalignment was present in 5 patients, 2 in the stable-knee and 3 in the stabilised-knee group. Mean preoperative range of passive flexion was 136° (90–150°) in the stable-knee group and 135° (135–140°) in the stabilised-knee group. An extension lag of 10° was noted in 6 patients (2 in the stable-knee and 4 in the stabilised-knee group). Table 1 reports the arthroscopic features of the meniscal lesions. No radial or complex tears were found.
Mean follow-up was 8.8 ± 0.87 years (7.6–9.9). At last follow-up, radiological evidence of osteoarthritis was seen in 13% of patients in the stabilised-knee group and none in the stable-knee group. Table 2 reports the objective IKDC scores before surgery and at last follow-up and Table 3 the MRI findings at last follow-up.

Importantly, the type of meniscal lesion differed significantly between the two groups: the proportion of vertical tears was 54% in the stable-knee group and 95% in the stabilised-knee group. The mean number of sutures was significantly greater in the stable-knee group (4.1 ± 1.80; 1–7) than in the stabilised-knee group (2.5 ± 1.14; 1–5), although tear length was similar (22.2 ± 7.19 mm and 21.5 ± 7.45 mm, respectively). This finding suggests that vertical tears could be reliably repaired with a smaller number of sutures compared to horizontal tears.

Table 1
Characteristics of the meniscal lesions.

<table>
<thead>
<tr>
<th></th>
<th>Stable knees n = 11</th>
<th>Stabilised knees n = 20</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tear in lateral meniscus</td>
<td>4 (30%)</td>
<td>4 (20%)</td>
<td>0.41</td>
</tr>
<tr>
<td>Tear in medial meniscus</td>
<td>7 (64%)</td>
<td>16 (80%)</td>
<td>0.01</td>
</tr>
<tr>
<td>Vertical tear</td>
<td>6 (54%)</td>
<td>19 (95%)</td>
<td></td>
</tr>
<tr>
<td>Horizontal tear</td>
<td>5 (46%)</td>
<td>1 (5%)</td>
<td></td>
</tr>
<tr>
<td>Tear length (mm), mean ± SD</td>
<td>22.2 ± 7.19</td>
<td>21.5 ± 7.45</td>
<td>0.90</td>
</tr>
<tr>
<td>Number of sutures, mean ± SD (range)</td>
<td>4.1 ± 1.80 (1–7)</td>
<td>2.5 ± 1.14 (1–5)</td>
<td>0.008</td>
</tr>
<tr>
<td>Distance from margin (mm), mean ± SD (range)</td>
<td>1.7 ± 1.84 (0–5)</td>
<td>1.9 ± 1.44 (0–5)</td>
<td>0.66</td>
</tr>
</tbody>
</table>

Table 2
Objective IKDC score before surgery and at last follow-up.

<table>
<thead>
<tr>
<th></th>
<th>Before surgery (%)</th>
<th>At last follow-up (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stable knees n = 11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>3 (27)</td>
<td>8 (72)</td>
</tr>
<tr>
<td>B</td>
<td>5 (45)</td>
<td>2 (19)</td>
</tr>
<tr>
<td>C</td>
<td>1 (9)</td>
<td>1 (9)</td>
</tr>
<tr>
<td>D</td>
<td>2 (19)</td>
<td>0</td>
</tr>
<tr>
<td>Stabilised knees n = 20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>3 (15)</td>
<td>11 (55)</td>
</tr>
<tr>
<td>B</td>
<td>2 (10)</td>
<td>7 (35)</td>
</tr>
<tr>
<td>C</td>
<td>11 (55)</td>
<td>2 (10)</td>
</tr>
<tr>
<td>D</td>
<td>4 (20)</td>
<td>0</td>
</tr>
</tbody>
</table>

4. Discussion

The main finding from this study is that meniscal repair is not followed by significant meniscal extrusion in the long-term.

Costa et al. [7] reported that meniscal extrusion greater than 3 mm was associated with severe meniscal degeneration and with extensive, complex, or large radial tears. These lesion types are associated with a high risk of developing early symptomatic osteoarthritis. Galeet et al. [9] showed that the amount of meniscal subluxation correlated strongly with the severity of radiographic joint space narrowing ($r = 0.56$, $P = 0.0001$). Thus, meniscal extrusion is associated with established or incipient osteoarthritis.

Pujolet et al. [8] demonstrated that high signal by MRI may persist even 10 years after meniscal repair. Therefore, MRI is not suitable for assessing meniscal healing after meniscal repair.

Furumatsu et al. [14] evaluated the length and width of the medial meniscus after concurrent meniscus repair and ACL reconstruction. Length increased and width remained unchanged. These findings suggest that meniscal repair may restore function by adjusting the antero-posterior length of the posterior segment of the medial meniscus. The assessment of meniscal extrusion morphology and RME in the coronal and sagittal planes in our study provides valuable information on long-term meniscus homeostasis after meniscal repair. RME standardises the measurement of extrusion, thereby allowing comparisons of knees of different sizes. This MRI measurement technique was validated previously in studies of lateral meniscus allografts and meniscal substitutes [13,15]. In these studies, implanting a meniscal substitute did not increase cartilage coverage by meniscal tissue, because meniscal defect filling

Fig. 4. Sagittal slice: measurement of cartilage coverage index.
was counterbalanced by increases in coronal and sagittal meniscal extrusion. Thus, meniscal substitutes may offer less chondroprotection than meniscal repair. AME in the coronal plane before surgery strongly predicted the clinical and morphological outcomes [15]. Therefore, preoperative coronal AME should guide the decision to use a meniscal substitute.

Other studies desire consideration when interpreting our results. There is convincing evidence that meniscal extrusion is associated with osteoarthritis. However, meniscal extrusion may be found in the absence of osteoarthritis. In a study of knees without osteoarthritis in patients with a mean age of 36.6 years, Puig et al. [10] found that extrusion was more common at the medial meniscus (68%) than at the lateral meniscus (18.8%).

A possible source of bias in our study is that MRI evaluates meniscal extrusion on static images taken with the patient supine and no weight-bearing by the lower limbs. During flexion and extension of the knee, the meniscus moves along its antero-posterior axis. Images taken with the knee extended therefore show only one possible location of the meniscus. Boxheimer et al. [16] demonstrated that meniscal extrusion varied with knee position and rotation and with weight-bearing.

After meniscal repair, osteoarthritic lesions are limited in the long-term. Meniscal function seems preserved and there is no significant meniscal extrusion.

Disclosure of interest

The authors declare that they have no competing interest.

References


