Complications in posteromedial arthroscopic suture of the medial meniscus

N. Jan a,*, B. Sonnery-Cottet b, J.-M. Fayard b, C. Kajetanek c, M. Thaunat b

a CHRU de Lille, Service d’orthopédie D, 59000 Lille, France
b Centre orthopédique Santy, FIFA Medical Center of Excellence, Groupe Ramsay–GDS, 69008 Lyon, France
c Hôpital universitaire Pité-Salpêtrière, 75013 Paris, France

1. Introduction

In the knee, long-term functional prognosis depends on the management of meniscal capital. Partial and total meniscectomy are associated with excellent early functional results and low revision rates, but increasing local pressure on the tibia impairs function over the medium-term and leads to radiologic damage and almost inevitable secondary osteoarthritis in the long-term, especially in case of associated chronic anterior instability [1–5].

Conversely, when repair is feasible, meniscal suture provides better distribution of stress and better clinical outcome, but with a higher rate of medial meniscal revision surgery [2,6,7], leading in turn to repeated suture or to meniscectomy (less extensive than would have been required as primary treatment without suture) [8].

In 1-step meniscal suture with anterior cruciate ligament (ACL) repair, failure rates are lower, but still high, especially in medial meniscal suture [9]. This difference may be due to problems of visualizing, freshening and suturing posterior horn lesions in the medial meniscus via an anteromedial arthroscopic portal [10].

The present study hypothesis was that hook suture of posterior horn lesions of the medial meniscus via a posteromedial portal, as first described by Morgan [11], reduces recurrence rates without unduly increasing the rate of complications associated with the supplementary portal.

* Corresponding author.
E-mail address: nicojan.nj@gmail.com (N. Jan).

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2. Material and methods

A single-center prospective non-randomized continuous study was performed between October 1, 2012 and March 15, 2013, including all patients presenting with a suturable longitudinal lesion of the posterior horn of the medial meniscus associated with ACL repair, managed by posteromedial all-inside hook suture (Suture Lasso™, Arthrex, Naples, FA). Two groups were distinguished: lesions restricted to the posterior horn underwent hook suture only; those extending to the middle and/or anterior segments underwent hook suture for the posterior horn and hybrid suture anchor and/or outside-in suture for the other segments.

Medial meniscal lesion was diagnosed arthroscopically on systematic exploration of the posteromedial compartment on a trans-notch view through the PCL. Lesions were deemed suturable in case of ramp lesion [12] or reducible lesions in the red-red (0–3 mm from the meniscosynovial junction) or red-white area (at 3–5 mm).

2.1. Surgical technique

Surgery was performed under general anesthesia and tourniquet, by 3 senior surgeons (BSC, JMF, MT). A knee bar and lateral support held the knee at 90°. A 30° arthroscope was used in all cases. Suturing was performed after transplant harvesting and ahead of ACL repair.

The first step was classical anterior exploration. After cartilage assessment and economic resection of non-suturable lesions, the palpation hook was introduced over then under the meniscus to exert traction. When this maneuver brought the posterior horn under the medial condyle, this was an indirect sign of meniscal lesion and indicated lesion instability (Fig. 1A). The medial tibiofemoral compartment was often narrow, preventing visualization of the posterior horn lesion via the anterior portal.

The second step consisted of exploration of the posteromedial compartment via the intercondylar notch. With the knee at 90°, the arthroscope was introduced in its sheath from the anterolateral portal toward the triangular interval defined inward by the axial side of the medial condyle, outward by the lower edge of the posteromedial bundle of the posterior cruciate ligament, and downward by the tibial spine (Fig. 1B). The arthroscope could be slid along the axial side of the medial condyle by a maneuver in valgus and flexion then extension. Once the arthroscope had been introduced, the knee was put at 90°. A movement of internal rotation was applied to the tibia by maneuvering the hindfoot with the palm of the hand; this exposed meniscal lesions of the peripheral two-thirds of the posterior horn, from the root to the junction between the middle and posterior segments. If no lesion was clearly seen, a needle introduced posteromedially detected hidden lesions [10] (Fig. 1C and D).

The third stage comprised the posteromedial portal, performed using a needle under arthroscopic control via the intercondylar notch. Transillumination located the vascular and neural structures to be avoided (Fig. 1C). The cutaneous entry point laid above the pes anserinus tendons, 1 cm posterior to the medial tibiofemoral joint line. The knee was held in 90° flexion, to keep the popliteal vascular and neural structures as far away as possible [13]. The needle was introduced from outside-in toward the lesion. The intra-articular entry point was checked arthroscopically so that the needle was within the quadrilateral contoured by the synovial fold of the adductor tendon above, the posterior part of the medial condyle in front, the synovial fold of the semi-membranous tendon below, and synovial fold of the medial gastrocnemius behind [14]. The portal was extended 5–10 mm vertically, using a n° 11 cold blade, with

Fig. 1. Hook suture of the posterior horn of the medial meniscus. X: location of posteromedial portal.
the same entry point, in the same direction, still under arthroscopic control.

The fourth step was hook suturing. Firstly, posteromedial debridement was performed, by shaver (Fig. 1E). The 25° hook (Suture Lasso™; Arthrex, Naples, FA) was introduced via the same portal. A right-hand hook was used in left knees. A single passage was enough to cross the peripheral and then central parts and deploy the non-resorbable suture (Fiberstick 2™; Arthrex, Naples, FA) (Fig. 1F and G). The suture was picked up by grasper introduced via the same portal. A running knot was tied to the most posterior part of the meniscus using a knot pusher, and the suture strands were cut by knot cutter (Fig. 1H).

In lesions extending to other segments, hook suturing was completed by hybrid suture anchor (FasT-Fix™; Smith & Nephew, Andover, MA) for the middle segment and outside-in resorbable suture (PDS® 1™; Ethicon Inc., Somerville, NJ) for the anterior horn. Suture stability was tested using the hook (Fig. 1I).

The procedure was if necessary continued with lateral meniscus suture and/or microfracture. Finally, ACL repair comprised an independent outside-in tunnel, conservation of the ACL remnant, juxta-articular fixation by resorbable interference screws, and double tibial fixation of the autograft.

2.2. Postoperative course

Walking was resumed systematically with two forearm crutches for 6 weeks, without splint. Total weight-bearing was resumed during the first 2 weeks, according to pain. Pain-free range of motion was recovered between 0° and 90° during the first 6 weeks. Activity in alignment on firm ground was resumed at month 3. Pivot sports without contact were resumed at month 6, and pivot sports with contact at month 9.

2.3. Assessment criteria

Suture failure was assessed as symptomatic recurrence of a medial meniscal lesion. Patients with ≥1 Barret criterion (joint effusion, painful point in the meniscus, McMurray positive, blockage) underwent CT arthrography [15,16] and, in case of findings of a medial meniscus lesion, were considered to be in symptomatic recurrence, whether requiring surgery or not. Differential laxity was assessed on rolimeter (Aircast, Boca Raton, FL). Intra- and postoperative surgical and non-surgical complications were inventoried. The severity of any sensory disorder was assessed by questionnaire.

2.4. Statistical analysis

Results were analyzed on XLSTAT™ (Addinsoft, 2015) software. Failure rates were analyzed on Kaplan–Meier survival curves. Subgroups were compared on log-rank test. The significance threshold was set at P < 0.05.

3. Results

3.1. Population characteristics

Between October 1, 2012 and March 15, 2013, 132 consecutive patients undergoing concomitant medial meniscus hook suture and ACL repair were included. Median trauma-to-surgery interval was 4 months (range, 1 week to 30 years). Median age at surgery was 26.4 years (range, 12–57 years); mean body mass index (BMI) was 24.3 (range, 16–34); male-to-female sex ratio was 5:1. The right knee was involved in 88 cases (66.7%). Twenty-three patients (17.4%) had history of ipsilateral ACL repair, and 3 (2.3%) had had a previous revision procedure. Median preoperative rolimetric differential laxity was 7 mm (range, 5–14 mm). The medial meniscal lesion was visible on preoperative MRI in 77 cases (59%). Fifty-one lesions (38.6%) showed extension to other segments; 81 (61.4%) were restricted to the posterior horn. Lesions were stable in 50 patients (38%), and unstable in 82 (62%), including 12 bucket-handle lesions (9.1%), 11 of which (8.3%) were sutured. Mean number of suture stitches of whatever type per medial meniscus was 2.5 (range, 1–6); mean number of hook stitches was 2.0 (range, 1–4); mean number of hybrid suture stitches with meniscal anchor was 0.5 (range, 0–3); and mean number of outside-in stitches with resorbable suture was 0.1 (range, 0–2).

Graft used gracilis and semitendinosus tendon in 89 cases, and patellar tendon in 41 cases; quadriceps tendon was rarely used (2 cases). Lateral tenodesis was performed in 33 cases. Subgroup characteristics are shown in Table 1.

3.2. Survival analysis

All patients were seen again, at a mean 31 months’ follow-up (range, 28–35 months). Fifteen showed meniscal symptoms, with ≥1 positive Barret criterion. CT arthrography was performed in 15 cases, showing 12 cases of symptomatic recurrence of a medial meniscus lesion. Recurrence rate was 9% and survivorship 91% (95% CI [0.860–0.958]) (Fig. 2). Four cases of recurrence (4.9%) were in the “limited” group and 8 (15.7%) in the “extended” group, which
was thus at significantly higher risk: 95.1% (95% CI [0.903–0.998]) versus 84.3% (95% CI [0.743–0.943]); \( P = 0.036 \) (Fig. 3).

### 3.3. Complications and surgical revision

#### 3.3.1. Intraoperative complications

The posteromedial portal was complicated by saphenous vein puncture in 2 cases (1.7%) in which transillumination was deficient; the portal was a few millimeters too anterior and proximal, without postoperative impact. There were no cases of material breakage or of positioning failure with hook suture.

#### 3.3.2. Postoperative complications

##### 3.3.2.1. Surgical complications

Ten of the 12 patients with symptomatic recurrence of medial meniscus lesion underwent revision surgery: i.e., 7.8%, or 92.2% survival (95% CI [0.870–0.974]) Mean interval to revision was 15.2 months (range, 5.3–29 months). The “limited” group \( (n = 81) \), with 3 revision surgeries, had a revision rate of 3.7%, 96.3% survival (95% CI [0.922–1.000]) and mean

<table>
<thead>
<tr>
<th>Population characteristics</th>
<th>Lesions limited to posterior horn</th>
<th>Extensive lesions</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients n (%)</td>
<td>81 (61%)</td>
<td>51 (39%)</td>
<td>132</td>
</tr>
<tr>
<td>Sex ratio (male/female)</td>
<td>4.8</td>
<td>5.4</td>
<td>5.0</td>
</tr>
<tr>
<td>Mean BMI (range)</td>
<td>24.2 (16–34)</td>
<td>24.6 (20–33)</td>
<td>24.3 (16–34)</td>
</tr>
<tr>
<td>Mean age (range)</td>
<td>28.2 (12–57.2)</td>
<td>27.9 (15.6–48.4)</td>
<td>28.1 (12–57.2)</td>
</tr>
<tr>
<td>Right side (%)</td>
<td>65%</td>
<td>69%</td>
<td>67%</td>
</tr>
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![Fig. 3. Survival analysis: recurrence of symptomatic medial meniscus lesion/subgroup comparison.](image-url)
interval to revision of 15.8 months (range, 13.1–17.8 months); in the “extended” group (n = 51), with 7 revision surgeries, the rates were 14.4%, 85.6% [0.745–0.956] and 14.9 months (5.3–29). The difference in revision rates was significant: P = 0.033.

The 10 revision surgeries comprised 1 resuturing and 9 meniscectomies. The repeat suturing was performed 16 months after primary suture of a ramp lesion; classic anterior exploration found an unstable lesion, and posterior exploration revealed healing failure with the suture in place. In the 6 meniscectomies, a smaller, more central lesion forward of the suture was found, classified as “postage-stamp” lesion or partial failure (Fig. 4) attributed to the suture tool; these lesions progressed, forming 2 flaps. In 3 cases, recurrence implicated repeat trauma, with ACL tear in 1 case, and pain on resumption of sport on the others.

Second-look arthroscopy was performed in 10 cases (7.6%) without meniscal symptoms: 7 Cyclops syndromes, 1 lateral meniscal suture failure, and 2 recurrences of ACL tear. The 2 cases of Cyclops syndrome showed partial healing; the lesion was considered stable and asymptomatic, and left in situ.

3.3.2.2. Non-surgical complications. None of the 9 patients (7%) with postoperative hematoma required surgery or transfusion. Two showed flexion contracture requiring rehabilitation in a specialized center; progress was good, without need for arthrolysis. There were 2 hematomas associated with the posterior portal, with favorable evolution without surgery.

Sensory assessment found no cases of pain on posteromedial surgical scar palpation, ruling out the possibility of neuroma. Twenty patients undergoing surgical revision were excluded from sensory assessment. Two patients (1.8%) reported dysesthesia in an area equal to or greater than the size of a credit card (45 cm²) (Fig. 5). Fig. 6 shows the size of the sensory impairment area according to type of graft.
4. Discussion

With a revision surgery rate of 7.8%, posteromedial suture of medial meniscal lesions seemed to improve healing without increasing morbidity due to the supplementary portal.

The mean failure rate of medial meniscal suture reported in the literature is 24% at 5 years, but with 30% of failures occurring later than 2 years [17]. There are biomechanical explanations [18–20] for this high rate of failure, but also a technical explanation in terms of the narrowness of access to the posterior horn on an anterior portal, compromising diagnosis, freshening and suturing. Alternatives (use of distractors, or medial collateral ligament “pie-crusting” using a needle [21–23]) have been proposed, improving visibility in the posterior horn but not in the most peripheral area, which is the site of a capsulomeniscal or ramp lesion in 16.6–40% of cases of ACL repair [10,12,24]. Posterior visualization of the posterior spaces through the intercondylar notch is therefore recommended as routine practice [25–28]. We systematically sutured these lesions, some of which were deemed stable, and this constitutes a study bias, although ramp lesions may also be unstable. The posteromedial portal provides a large work space for freshening and suture [16], enabling vertical stitches perpendicular to the deep meniscal fibers, which are thus more biomechanically robust [29–31]. Unlike with all-inside hybrid suture anchor, posterior horn lesion reduction is visualizable intraoperatively, and in the present series, there were no cases of positioning failure or implant migration, which might cause osteolysis [11,32,33]. One hook can be used for several sutures.

Medial meniscus healing failure following hybrid suture anchor or outside-in suture seems to implicate the posterior horn [34,35]. Adding hook suture [11,36] to the therapeutic armamentarium seems to improve healing in posterior horn suture. Ahn et al., in second-look arthroscopy at a mean 38 months, found a significant difference in healing rates between extensive lesions (92%) and hook suture of lesions restricted to the posterior horn (99%) [37,38]. Although systematic second-look arthroscopy following meniscal suture does not allow assessment of recurrence [39], results were comparable in the present series, where extensive lesions were associated with higher risk of recurrence of the medial meniscal lesion and of revision surgery. Meniscal suture may cause new lesions (Fig. 4). Lesions adjacent to hybrid sutures were reported in 35% of cases on systematic repeat arthroscopy [40]. These lesions may underlie the “partial failures” described by Pujol et al. [8]; they were smaller than the primary lesions, represented 35% of failures, and were systematically associated with the posterior horn. In the present study, 3 out of 5 failures were “partial”; but no posterior horn lesions were larger than the primary lesion.

Comparison with results for classic suture is difficult. Unlike in the present series, populations were often heterogeneous: stable or unstable knees, medial or lateral menisci, and varying assessment criteria, affecting results [41–50]. Hook suture has been little assessed: comparison of meniscal lesion recurrence rates between hook suture and inside-out or hybrid suture anchor finds no significant differences [51,52]. No complications implicating the portal were reported.

The main risks of this portal concern the saphenous nerve and vein: anatomic studies situate the portal at less than 1.5 cm [14,53,54]. Clinical follow-up of 179 patients managed with a posterior portal found no major complications, but 3 cases (1.7%) of residual hypoesthesia in the saphenous nerve territory and 2 of greater saphenous vein puncture [54]. In the present series, the rate of saphenous vein lesion implicating the posteromedial portal was hard to specify, as hamstring tendon harvesting, performed in two-thirds of cases, is associated with postoperative sensory impairment in the various (infraapatellar and/or sartorius) saphenous nerve territories in 74% of cases [55].

Posterior horn hook suture thus allows visualization, effective freshening and several vertical sutures with a single hook without increased morbidity due to the supplementary portal; the rate of secondary meniscectomy at a minimum 28 months follow-up was low. A certain risk of failure has to be run, especially as it is low and only partial. Posterior horn healing seems to be better, with a low rate of recurrence and good post-meniscectomy volume. Caution, however, is warranted, as 30% of failures occur later than 2 years [19].

Disclosure of interest

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