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Posterior horn instability of the medial meniscus a sign of posterior meniscotibial ligament insufficiency

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Abstract
Purpose In longstanding chronic anterior cruciate ligament (ACL) insufficiency, we identified an abnormal movement of the posterior medial meniscal horn, likely due to insufficiency of the posteromedial meniscotibial ligament. Passing from extension to flexion or vice versa, the medial posterior horn slides below the posterior rim of the tibia exposing the tibial plateau. Fixation with suture anchors of the meniscotibial ligament through a posteromedial portal restored normal meniscotibial tension and reduced instability of the meniscal posterior horn. The purpose of the present study was to present the arthroscopic features of posterior medial meniscus instability and to report results following arthroscopic repair.
Methods During the two-year study period, from 2007 through 2008, this arthroscopic feature was detected in 12 patients, 5 patients had failure of a previous ACL reconstruction and 7 patients had delay in ligamentous reconstruction for various reasons. All patients were affected by severe anterior–posterior translation with 11.3 ± 4.3 mm of side-to-side difference at KT-2000 and by associated rotatory laxity with grade 3 of pivot shift.
Results At follow-up of 1 year, the combined ACL reconstruction and fixation of the posteromedial horn showed a reduction in the rotatory and anteroposterior laxity.
Conclusions This study suggests the importance of a proper arthroscopic evaluation of the posterior medial capsule in patients with chronic ACL insufficiency and highlights the potential presence of an unstable posterior horn of the medial meniscus as an indirect arthroscopic sign of peripheral laxity.
Level of evidence Retrospective chart review, Level IV.

Keywords Meniscus · Arthroscopy · Knee · ACL · Posteromedial capsule

Introduction

The anterior cruciate ligament (ACL) rupture occurs frequently and if not treated leads to changes in the kinematics of the knee joint. If the knee remains unstable, the laxity continues to worsen, resulting in the secondary damage of menisci and of the peripheral structures [5, 6, 13, 19, 20, 25, 26]. This scenario has become less frequent in recent decades, as several studies on nonoperative treatment reported a high rate of osteoarthritis, thus prompting surgeons to advocate early surgical treatment after an ACL tear [14, 28]. Despite this recognition of the need for early surgical repair, we have treated patients with a history of longstanding instability. This group is comprised of patients with failure of previous ACL reconstruction or patients who for various reasons had refused an ACL reconstruction and were treated with meniscectomy only. This subset of patients shows constant and severe anterior–posterior and rotatory laxity. In addition to involvement of menisci and/or of articular cartilage, arthroscopic examination of the posteromedial capsule shows evidence of hypermobility or laxity of the medial meniscus posterior horn. Passing from extension to flexion or vice versa, we have observed the meniscus or the meniscal remnant (if the meniscus had been previously removed), sliding below the posterior edge of the tibia and exposing the tibial plateau. This finding is different from

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those seen in the presence of a medial meniscal root avulsion or tear occurring as a single traumatic event or more commonly following chronic degenerative diseases. Moreover, in posterior root avulsion, the lesion is located within the body of the meniscus or at its root attachment and is not associated with ligamentous injury. The finding that we have detected is always associated with rotatory laxity, and we believe that the main cause of this meniscal laxity could be a posterior meniscotibial ligament insufficiency occurring either at the moment of initial injury or later following the progressive stretching of this ligament during recurrent instability episodes. Regardless of the cause, our finding is in some ways very similar to the Bankart lesion seen in recurrent dislocation of the shoulder. For this reason in order to restore the proper tension of the posteromedial capsule, we have treated the lesion with sutures anchoring the meniscus and its capsular attachment to the posterior edge of tibia.

The purpose of this article is to present the arthroscopic features of this lesion and to describe the clinical presentation and outcome of its arthroscopic repair.

Materials and methods

During the 2-year study period (2007 through 2008), 453 consecutive arthroscopic ACL reconstructions were performed and a clear finding of posterior medial meniscus hypermobility was identified in 12 patients. Of this subset, all 12 were followed up for a mean of 12 months. Demographic data as well as preoperative and postoperative objective data were analyzed. Specifically, physical examination data including results of meniscal and laxity tests were recorded. The preoperative diagnosis of chronic ACL was made on the basis of clinical examination, and all patients had the diagnosis confirmed by at least one MRI. Measurements of anteroposterior translation with a KT-2000 arthrometer (MED metric, San Diego, CA) were also obtained preoperatively and at postoperative follow-up. Of the 12 patients, 9 were men and 3 were women; there were 7 right knees and 5 left knees. Median age was 36 years (17–51). Of 12 patients, five patients had a failure of previous ACL reconstruction, three performed with patellar tendon and two with hamstrings. The median time from the previous surgery to index procedure was 3.8 years (2–5). In the other 7 patients, the ligamentous reconstruction was delayed for different reasons: in 3 for impossibility of affording a long period away from work, in 2 for fear of surgery and/or inactive life style, and in 2 for presence of open physeal plate. In this group of patients, the median time elapsed from injury to surgery was 6 years (2–28). One patient, the oldest in term of elapsed time from injury (28 years), had only a peripheral repair of the POL without ACL reconstruction. All patients had a clear history of instability. The pain was most often moderate and related to giving-way episodes. Ten patients complained of posterior knee pain and joint line tenderness. The preoperative median IKDC subjective evaluation score was 59 (28–78). On physical examination, 9 patients showed marked laxity with at least a grade 3 Lachman test (>10-mm translation) and 3 patients had a grade 2B Lachman test (5- to 10-mm translation without a firm end point). The examination revealed a grade 3 pivot shift test in all patients. Three patients had 2+ and 5 patients had 1+ of valgus laxity. At KT-2000, the median preoperative side-to-side difference at manual maximum displacement was 11.3 ± 4.3 mm (range, 6–14 mm). The average preoperative Lysholm score was 56 (23–73). Regarding the meniscal pathology, in 8 patients the meniscus was previously removed and in 4 patients a bucket-handle was present at index procedure.

MRI was available in all patients, and in one patient, affected by ACL graft failure, an MRI with gadolinium contrast was performed in another hospital for a proper ACL graft evaluation. At the beginning of our study, in all patients, neither the radiologist nor the orthopedic surgeon noticed any pathology of the posteromedial compartment. Later, in a retrospective analysis of the images, we detected some constant findings that could raise the suspicion of this pathology as follows: (1) redundancy of the meniscotibial ligament (2) hyperintensity of the meniscus remnant, and (3) localized hyperintensity of the posterior tibial edge in the T2-weighted images (Fig. 1). Signs of meniscal radial extrusion were not detected in any patient. At radiological examination, presence of osteophytes located at the posterior medial margin of the tibia was detected in 3 patients

Fig. 1 MRI of the knee (sagittal T1-weighted sequence) with hyperintensity of the remnant of posterior horn with redundancy of the meniscotibial ligament

and confirmed at arthroscopy. In the remaining 9 patients (75%), different degrees of cartilage damage, such as softening or erosion, at posterior medial tibial plateau were detected only at arthroscopy.

Surgical treatment

Arthroscopy was carried out with regional anesthesia. The limb was placed on a table with a lateral post at the level of the mid-thigh. A standard arthroscopic examination of the knee was performed using the anterolateral portal. Through this portal, the arthroscope was inserted into the medial aspect of the intercondylar notch and advanced until it entered the posteromedial compartment. The limb was held free on the table with the hip and the knee flexed at 90 degrees. A careful inspection of the posteromedial capsule was performed, and subsequently the knee was extended to 30 degrees or more if possible and the posterior horn of medial meniscus and its capsular attachment were examined. In presence of posterior horn instability, it was possible to observe passing from flexion to extension a posterior movement of the meniscus that slides down or remains floating exposing the posterior rim of the tibial plateau (Figs. 2, 3). The meniscotibial ligament was redundant, and there was no firm attachment of meniscus to the tibia as seen normally. If posterior sliding of the meniscus was detected, a cannula was placed at the posteromedial portal. Through this portal, the menisco-capsular junction was held with an arthroscopic grasper for the assessment of the necessary tension. The underside of the meniscus and the capsule were abraded. With an arthroscopic shaver, the posterior margin of the tibia was also abraded in order to create a bleeding bone surface. One or two suture anchors were placed onto the tibial margin. The sutures were passed through the menisco-capsular attachment with a crescent-shaped suture hook penetrating the menisco-tibial ligament and were tied above the meniscus with a sliding knot. Then, the knee was extended and flexed several times in order to evaluate suture stability (Fig. 4). In two patients, the capsular suture was passed in one transtibial tunnel performed from anterior to posterior and tied out through the anterior tibial cortex. After re-fixation of the meniscotibial ligament, ACL reconstruction was performed by a trans-tibial technique. After having fixed the meniscus and the meniscotibial ligament and prior to ACL reconstruction, we performed an intraoperative clinical evaluation and found reduction of pivot shift test from a grade 3 to grade 1 in all patients. The patients in whom this procedure was performed followed the same ACL postoperative protocol. This involves CPM from 0–90 degrees starting the second day after surgery which continues for 2 weeks and full weight bearing as soon as tolerated. Immobilization in a knee brace locked at 0 degrees flexion is prescribed during deambulation for the first month only. The use of brace is discontinued as the patient learns to walk with a straight knee. Two to four weeks after surgery, work-outs are supplemented with closed kinetic chain exercises,

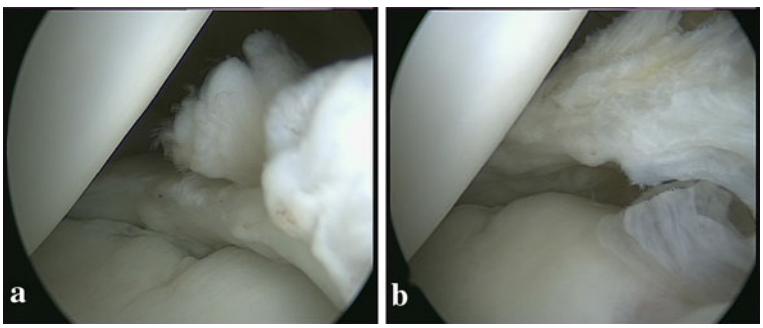

Fig. 2 **a** Remnant of the posterior horn of medial meniscus (left knee) is seen at 90° and in **b** remnant seen at 30° of knee flexion after meniscectomy for a bucket-handle tear. The remnant is floating above the posterior tibial margin that shows initial signs of damage. Evident the redundancy of meniscotibial ligament

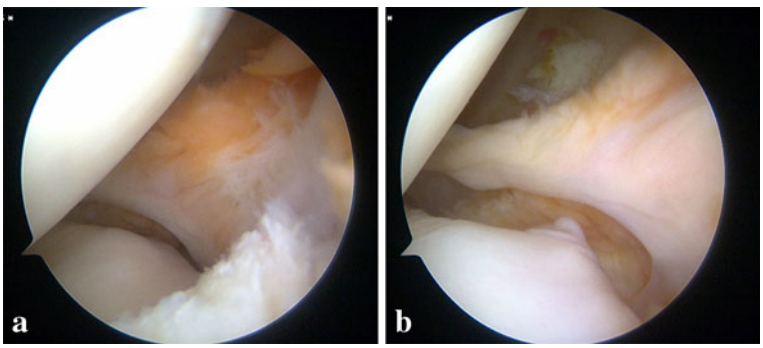

Fig. 3 A meniscal remnant of posterior horn after meniscectomy (left knee) in a patient affected by chronic ACL tear, seen at 90° (**a**) and at 30° of knee flexion (**b**). The meniscal remnant is displaced off the joint and exposes the tibial plateau

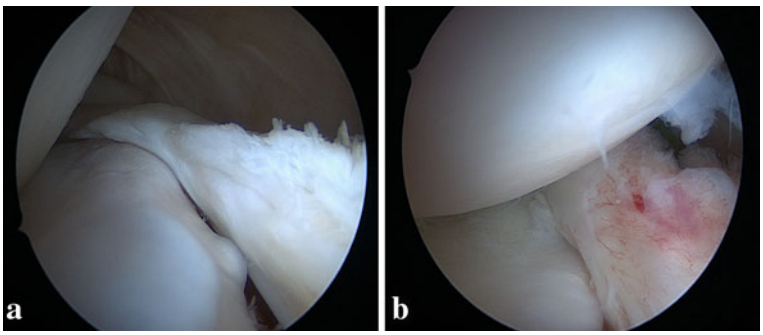

Fig. 4 A meniscal remnant of posterior horn seen at 90° of knee flexion sliding below the posterior border of the tibia before (**a**) and after (**b**) transtibial fixation

low-resistance stationary cycling and swimming. Progressive resistance exercises are started 4 weeks postoperatively. Running and biking are allowed after 2 months. Unrestricted return to training of pivoting activities is permitted at 3 months, and return to agonistic sports without a functional brace is allowed at 6 months.

Results

All patients were evaluated postoperatively at 6 months and 1 year, and at final evaluation, both the IKDC subjective evaluation and Lysholm scores improved to 89 (75–100) and 90 (80–100), respectively. Subjectively, none of the patients seen at follow-up reported episodes of the knee giving way. According to the IKDC objective assessment, 7 patients were graded as normal, 4 as nearly normal, 1 as abnormal, and none as severely abnormal. The KT-2000 evaluation showed a significant decrease in anterior tibial translation and the average difference between injured and uninjured joint at manual maximum displacement was 1.8 mm. Eight patients (66%) had a difference of 1–2 mm, and 4 patients (33%) had a difference of 3–5 mm with the opposite knee. None of the patients had a difference of more than 5 mm. The pivot shift test was negative in 11 patients and nearly normal ("glide") in one. The varus or valgus tests were negative in all cases. There were no specific complications or complains related to the surgical procedure, such as effusion, joint line tenderness, or a positive McMurray test.

Discussion

The principal findings of the present study are that in longstanding instabilities for ACL insufficiency and for rotatory laxity, there is meniscal instability and an involvement of the posterior medial capsule that is often unrecognized at arthroscopy. A proper arthroscopic evaluation of the posterior medial capsule, carried out at different degrees of knee flexion, shows the presence of an unstable posterior horn of the medial meniscus or of meniscal remnant that slides below the posterior rim of the tibia exposing the tibial plateau. This abnormal meniscal translation is likely due to insufficiency of the posteromedial meniscotibial ligament.

Arthroscopic visualization of the posteromedial compartment is not considered a routine step during arthroscopic examination for the difficulties in reaching this compartment or fear of potential risks. Furthermore, during the examination of the posterior compartments, the attention of many surgeons is addressed only toward meniscal pathology or detecting loose bodies [1, 2, 7, 18], neglecting examination of the posteromedial capsule and of ligamentous pathology that must be performed in our opinion both in near full extension and in flexion of the knee.

There is clear evidence from cadaveric and in vivo studies [24, 27] that menisci are mobile both in an anterior–posterior direction (translation movement) and in a lateral–medial direction (radial movement) during the flexion and extension of knee. The translation movements are maintained by anatomic stabilizers, which for the medial meniscus include the medial collateral ligament and the meniscotibial ligament. If one of these supporting structures is torn, the meniscus may become unstable. While a posterior displacement of the anterior horn occurs normally during knee flexion and increases with a longitudinal meniscal tear [3, 8], the posterior horn is relatively fixed to the tibia for its tight attachment to the capsule and for the concave aspect of medial tibial plateau: this prevents the displacement of the posterior horn posteriorly. The relative immobility of the posterior horn may account for the frequency with which this part is torn in association with ACL tear. Whereas radial protrusion is easily detected with MRI, the diagnosis of an anterior–posterior movement is more difficult. This type of meniscal mobility can be detected either using an open MR scanner, which is not available for routine diagnostic purposes, or at arthroscopy passing from flexion to extension of the knee.

In all patients of the present study, meniscal pathology was present: 8 patients underwent previously medial meniscectomy and in 4 there was an associated bucket-handle tear at index surgery. We cannot establish whether the meniscectomy adversely affected the posteromedial

capsule stability or whether the capsule was damaged at the moment of initial injury or at a later time [17, 19, 21]. However, it is probable that the absence of the medial meniscus worsened ligament tension and allowed the meniscal remnant and its capsular attachment to slide, laying bare the tibial posterior margin with knee flexion. It is also possible that the absence of the posterior meniscal horn allowed us to easily detect the displacement of the remnant during knee movements that otherwise would have been difficult to observe if intact. Similarly, we cannot establish whether the cartilaginous or bony changes that we observed in 91% of our patients occurred at the time of injury or subsequently due to repetitive episodes of instability or were due to the absence of a meniscal posterior horn. It is well known that presence of osteophytes located at the posteromedial tibial margin is a common radiological sign of knee laxity. This osseous lesion may be worsened by instability of the posterior horn as detected in 3 of our patients.

During the same period of this study, we observed other patients who underwent medial meniscectomy before ACL reconstruction but we failed to detect the abnormality of the menisco-tibial attachment or meniscal hypermobility. For this reason, we hypothesize that our finding is not related to a previous meniscectomy but to a meniscotibial insufficiency responsible for the anteromedial rotatory instability [9, 10] that was worsened by the meniscectomy itself. Recently, biomechanical studies have underlined the importance of posteromedial capsule in rotatory control of the knee [22, 29]. The posteromedial capsule and the meniscus, with its shock-block effect, act as an important functional unit in restraining knee tibial internal rotation and valgus [22]. In longstanding knee laxity, the peripheral structures may become stretched because of episodes of giving way or may be damaged at the moment of the initial injury. All our patients suffered a severe rotatory instability, and after anchoring the capsule and the peripheral meniscal rim, it was possible to observe in all cases a reduction in the pivot shift and valgus stress. The biomechanical implications of a rotatory laxity and its surgical treatment are beyond the aim of this paper but it is our personal belief that in the knee rotatory laxity the medial peripheral structures are frequently damaged but often overlooked.

Sims and Jacobson [23] recently highlighted the importance of the meniscotibial ligament. In their review of arthroscopic examination findings, they detected in 19 of 31 patients gross instability and elevation of the meniscus off the tibia during abduction stress testing, the so-called meniscal rise. In reality, this sign shows the involvement of the medial or deep meniscotibial ligament in the middle part of meniscus. Similarly, the findings in our present series suggest damage in the posterior part, involving the posteromedial corner and/or the posterior meniscotibial ligament and leading to instability of the posterior horn.

This posterior meniscal instability is a distinct entity and should be differentiated from meniscal root avulsion. Severe ACL insufficiency was detected in all our patients, the symptoms were characterized mainly by knee instability, and there was no gender prevalence. Moreover, in posterior meniscal root avulsion, the detachment occurs as a radial-type tear and generally extends to its periphery with a progressive radial extrusion [11, 12, 15, 16], whereas in the posterior horn instability, as observed in this series of patients, the meniscal root was found intact, the meniscal tear was of a longitudinal type, and at MRI there was no sign of meniscal extrusion [4, 25].

The present study has several limitations that require consideration. The first weakness of this study is the small number of patients and the lack of a control group. Indeed, patients with longstanding instability are rare, and this prevents to collect a number of patients large enough to randomize into two groups. Second, we do not know the exact type of injury that our patients sustained and therefore cannot provide information on findings related to the first injury and on the number or severity of instability episodes. Third, we cannot establish whether our findings were primarily due to medial meniscus absence or insufficiency of the meniscotibial ligament.

Nevertheless, the present study shows the importance of a proper evaluation of the PMC in patients with chronic ACL insufficiency. The purpose of the present paper was to draw surgeons' attention to the presence of direct or indirect arthroscopic signs of peripheral laxity that could be detected by careful visualization of all peripheral structures. It is interesting to observe that while we are able to detect at arthroscopy an acute lesion of PMC that can be easily recognized through direct findings such as ecchimosis, meniscal, or femoral avulsion, we are still not able to arthroscopically diagnose chronic insufficiency of the PMC and we still consider and treat all chronic ACL lesions as isolated.

Conclusion

This study suggests, in patients with chronic ACL insufficiency, the importance of a proper arthroscopic evaluation of the posterior medial capsule which must be carried out at different degrees of knee flexion and highlights the potential presence of an unstable posterior horn of the medial meniscus as an indirect arthroscopic sign of peripheral laxity. It is our belief, although we cannot prove it, that in our patients anchoring the PMC to the posterior margin of tibia improved outcome after ACL reconstruction.

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