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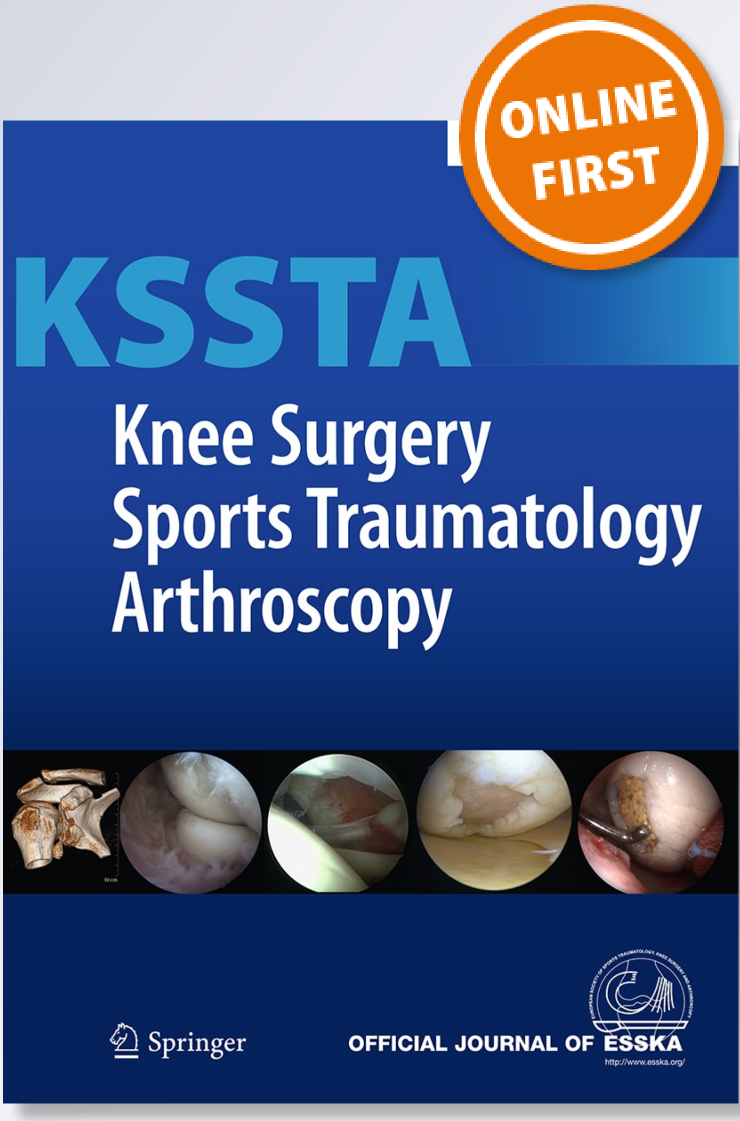

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A novel technique for combined medial collateral ligament and posterior oblique ligament reconstruction: technical note

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Abstract
Purpose In the last year, we have performed a new technique for combined medial collateral ligament (MCL) and posterior oblique ligament (POL) reconstruction in chronic setting of anterior cruciate ligament and MCL complex deficiency. Autogenous semitendinosus tendon with the tibial attachment preserved has been used for the medial/posteromedial compartment reconstruction. We describe the operative technique.
Methods Between January and December 2014, 12 consecutive patients with multiligamentous injuries underwent concomitant MCL/POL using a novel technique. The usefulness of the novel technique is the semitendinosus sling on the semimembranosus tendon and the POL fixation with the knee in full extension.
Results An ideal anteroposterior and rotational stability avoiding the medial compartment over constraint was achieved, in the immediate after surgery, due to the sequence of the bundle fixations and to the semitendinosus sling below the semimembranosus tendon.
Conclusions This technique is easily reproducible and useful and restores the medial stability immediately after surgery.

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Keywords Posteromedial corner · Medial collateral ligament · Posterior oblique ligaments · Multiligamentous knee injury · Semitendinosus sling

Introduction

Injury of the medial collateral ligament (MCL) complex typically heals with favourable results without any surgical treatment, especially in case of grade I and grade II injuries [18]. However, grade III MCL lesions, in particular those associated with other ligamentous injuries such as the anterior cruciate ligament (ACL) [9, 18], may lead to chronic instability followed by disability [17, 23]. Those patients often develop anteromedial rotatory instability (AMRI) combined with MCL and posteromedial corner (PMC) injuries [13]. It is documented that 99 % of medial injuries requiring surgical treatment had an associated injury to the posterior oblique ligament (POL), which was overlooked in many reports [20]. The POL and the PMC have an important role in medial static and dynamic stability. Additionally, repair of the MCL without POL treatment cannot restore the complete medial knee stability [13, 20].

According to LaPrade et al. [15], the superficial MCL (s-MCL) is formed by one femoral and two tibial attachments (proximal and distal). The femoral attachment is characterised by an oval shape, and it is located at an average of 3.2 mm proximal and 4.8 mm posterior to the medial femoral epicondyle. The proximal tibial attachment is strongly connected to the anterior arm of the semimembranosus tendon, and its average distance from the tibial joint line is 12.2 mm. The distal tibial attachment of the s-MCL is located just anterior to the posteromedial crest of the tibia, and its average distance from the tibial joint line is 61.2 mm. Biomechanically, the s-MCL provides the

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greatest stability against valgus forces over the entire range of motion (ROM). The load on the s-MCL is highest in external rotation, especially from 30° to 90° knee flexion [11].

The structures of the PMC are located posterior to the border of the longitudinal fibres of the s-MCL up until the medial border of the posterior cruciate ligament. The PMC structures include the POL, the semimembranosus expansions, the posteromedial horn of the meniscus, and the oblique popliteal ligament [23].

The POL consists of fascial attachments extending from the semimembranosus tendon, immediately posterior to the superficial MCL. The POL has three separate arms: a tibial or central arm, a capsular arm which blends with the oblique popliteal ligament, and a superficial arm which blends with the superficial MCL [23]. The central arm is considered to be the main component of the POL, arising from the main arm of the semimembranosus tendon, reinforcing the deep MCL, and directly attaching to the posterior joint capsule and posterior meniscus [15].

The POL is in tension and provides stability to valgus forces, posterior tibial translation, and internal rotation when the knee is in full extension [19]. External rotation of the tibia significantly increases when the MCL complex and PMC are both incompetent.

Numerous surgical techniques to treat injuries of MCL have been introduced in the surgical practice, from direct repair of the MCL to the retensioning of the posteromedial structures. However, studies have shown that reconstruction can achieve better clinical results compared to simple repairing or retensioning [3–5].

Over the past years, various surgical techniques have been focused on treatments of chronic medial instability, such as the concomitant reconstruction of MCL and POL with double bundle [2, 5, 23]. The main limitation of the techniques described in the literature is related to POL fixation. Moreover, the two bundles were usually fixated with the knee in slight flexion as described by several authors [6, 7, 14, 16, 21, 24, 25], which could put at risk of medial overconstraint at full extension.

In the last year, we have performed a new technique for combined MCL and POL injuries, using autogenous semitendinosus tendon while preserving the tibial attachment, by passing underneath the semimembranosus tendon and fixating the POL bundle with the knee in full extension.

The clinical relevance is to recommend the use of this new technique for combined POL and MCL reconstruction because the procedure is relatively easy to perform and it is reproducible and respects the anatomical and biomechanical features of the medial capsuloligaments complex. Hereby we describe the new operative technique.

Materials and methods

Between January and December 2014, 12 patients (7 males, 5 females) with a median age of 38 years (range 20–55) underwent combined ACL, MCL and POL reconstruction with a novel technique that we designed just for the medial compartment. Inclusion criteria were chronic combined ACL complete tear (>6 weeks from the injury) and grade III MCL injury [10] with AMRI defined as an anterior subluxation and external rotation of the medial tibial plateau around the central axis of the posterior cruciate ligament (PCL) [1, 5]. AMRI was clinically assessed performing an anterior drawer test with the knee flexed at 90° and the foot held in 10° external rotation [13].

All patients underwent thorough preoperative assessment including standard knee X-rays, merchant view, weight-bearing full-length lower limb radiographs, and MRI to assess the medial/posteromedial ligamentous injuries [8] and the associated lesions. Examination under anaesthesia was performed in all patients before surgery to confirm the preoperative diagnosis.

All surgeries were performed by the same surgeon at our institution.

Surgical technique

Arthroscopic evaluations and ACL reconstruction

Patients were positioned as standard ACL reconstruction and in a figure four position for the medial compartment reconstruction. Arthroscopic joint evaluation was performed in all patients. Applying a valgus force, a medial femorotibial increased gap with positive drive through sign was visible.

ACL was reconstructed with the preferred technique of the authors [12] (arthroscopic transtibial single-bundle reconstruction technique) using hamstrings or anterior tibialis allograft tendons. The ACL tibial fixation was performed after MCL and POL reconstruction.

Reconstruction procedure of MCL–POL

A curved medial skin incision was directed from the medial femoral epicondyle to the pes anserinus. The fascia was exposed, and the semimembranosus tendon, the medial femoral epicondyle, and the hamstrings were identified. Pes anserinus tendons were isolated, and the semitendinosus tendon was then harvested without detaching it from its insertion on the tibia. The free end of the tendon was prepared with a baseball suture fashion using a No. 2

resorbable braided Vicryl wire (Ethicon, Johnson & Johnson, Livingston, Scotland, UK).

Reconstruction of the POL

The direct arm of the semimembranosus tendon was isolated through a small oblique fascia incision 1.5 cm distal from the posteromedial joint line level. The free end of the graft was then passed underneath the fascia and gracilis tendon, superficial to the s-MCL, and then underneath the direct arm of the semimembranosus tendon, creating a semitendinosus sling (Fig. 1).

The medial femoral epicondyle was exposed, and the femoral MCL insertion site was then identified. An eyelet K-wire was drilled in the centre of the femoral MCL insertion with posterior–anterior and distal–proximal directions.

The graft was passed below the fascia and looped around the K-wire. It was held with a Kelly clamp taut distally along the direction of the anterior bundle of the s-MCL in constant tension. A full ROM cycle was performed in order to test the isometry of the femoral insertion point. Tendon migration greater than 2–3 mm was not tolerated.

When the proper femoral position was found, the graft was tensioned (manually to a maximum) with the knee in full extension passing over the K-wire to determine the right length (Fig. 2). Three landmarks were marked on the graft with a skin-marking pen to define the position and length of the tendon double loop to be inserted in the femoral tunnel. One point is signed at the insertion of the graft with the K-wire, and two landmarks were marked distally at 2.5 and 5 cm, respectively, from the first point (Fig. 3). A No. 2 Fiberwire (Arthrex, Naples, Florida, USA) is passed on the middle one point, and the tendon was double-looped. The tendon was sutured with No. 2 Vicryl wire baseball suture fashion up until the 2.5-cm distal signs (Fig. 4).

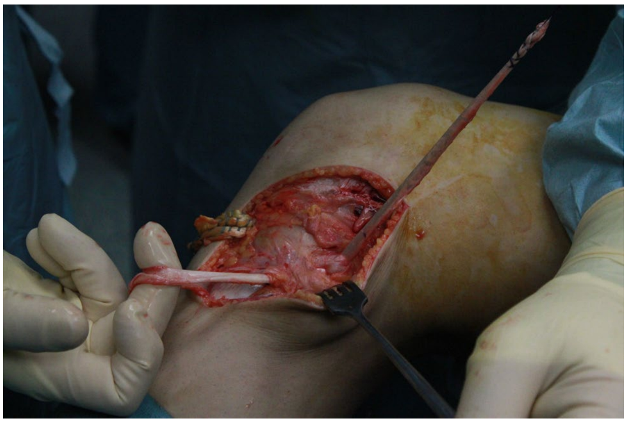

Fig. 1 Passage of the graft under the semimembranosus tendon: after the identification of the direct arm of the semimembranosus tendon, the free end of the graft is passed under the direct arm of the semimembranosus tendon in order to create a semimembranosus sling

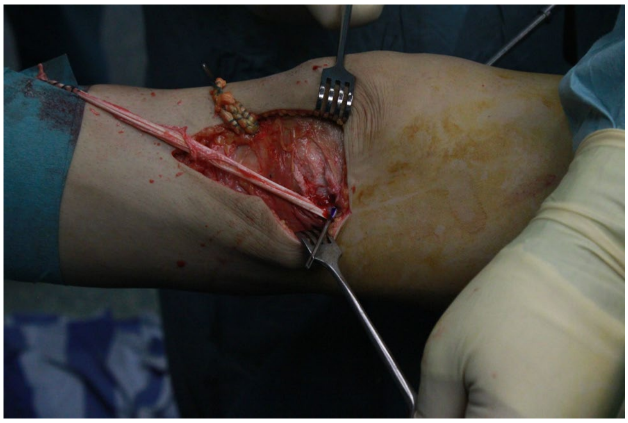

Fig. 2 Graft preparation: the graft was tensioned (manually to a maximum) with the knee in full extension passing over the K-wire to determine the right length, and the tendon was marked with a skin-marking pen at its insertion with the K-wire

Fig. 3 Landmarks: two more landmarks are marked on the graft distally at 2.5 and 5 cm, respectively, from the first point

A 3-cm femoral half-tunnel was drilled according to the measured diameter of the double-looped tendon. The sutured loop was then passed into the tunnel with a pull-through technique, passing the Fiberwire through the loop at the tail of the eyelet K-wire. The graft was fixed with a Biorci-HA (Smith&Nephew, Andover, Massachusetts, USA) interference screw of the same diameter and length as the drill tunnel (Fig. 5). The POL bundle was tightened (manually to a maximum) and fixated with the knee in full extension and neutral rotation. Finally, POL reconstruction is achieved.

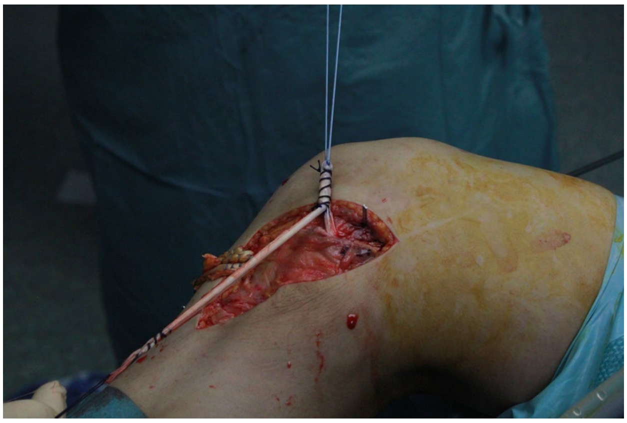

Fig. 4 Double-loop graft harvesting: the tendon is double-looped and kept on its central landmark with a No. 2 Fiberwire (Arthrex, Naples, Florida). The graft is sutured with No. 2 Vicryl wire baseball suture fashion up until the 2.5-cm distal signs

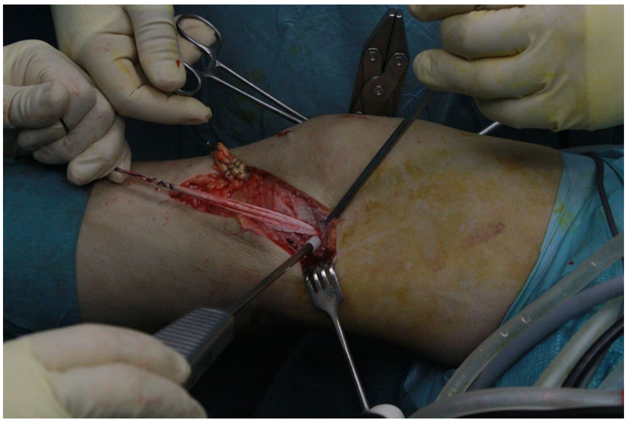

Fig. 5 POL graft femoral fixation: after the passage of the sutured loop into the 3-cm femoral half-tunnel, the POL reconstruction is completed with the femoral fixation of the graft. Fixation is obtained with the knee in full extension and neutral rotation by interference screw

Reconstruction of the MCL

Approximately 6 cm distal to the joint line and anterior to the posteromedial crest of the tibia, a small incision on the fascia exposes the distal insertion of the native s-MCL. The free end of the graft that comes out from the femoral half-tunnel is then passed distally underneath the fascia and the distal insertion of the gracilis tendon. It was fixated with a low-profile titanium staple 6 × 20 mm near the native MCL insertion point, in order to reconstruct the superficial bundle of the MCL (Fig. 6). The graft was tightened and fixated with the knee at 40° of flexion and neutral rotation with a gentle varus force applied.

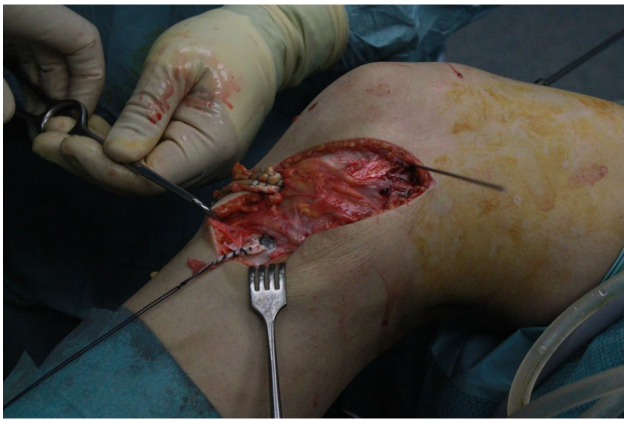

Fig. 6 MCL graft tibial fixation: MCL graft is passed distally under the fascia. Tibial fixation is achieved with a low-profile staple on the native MCL insertion point. Graft fixation is performed with the knee at 40° flexion and neutral rotation with a gentle varus force applied. The reconstruction is finished

An ultimate manual valgus stress test is applied during the all ROM at the end of the procedure to verify the optimal tension of the two bundles.

Postoperative treatment and rehabilitation

Weight-bearing was not allowed for 4 weeks after surgery. Thereafter, weight-bearing with crutches was gradually practised until full weight-bearing was achieved in 2 weeks. A brace is positioned with a ROM 0–90° for 2 weeks. From the third week, patients started active exercises. At 6 weeks after surgery, the patients began progressive activities, removing the brace during rehab phase but wearing it during daily activities for minimum 12 weeks, to avoid valgus and rotational stresses.

Results

The novel technique seems to restore a good stability of the medial compartment at the time of the surgery. This procedure showed to be easily reproducible and respects the anatomical and the biomechanical features of the medial capsuloligament complex.

The use of the autologous semitendinosus tendon, with preserved tibial attachment and a sling passing underneath the direct arm of semimembranosus tendon, is useful to obtain a dynamic stabilisation at mid-flexion as described by Kim et al. [14] and Stannard et al. [22]. The POL femoral fixation is quick and easy, and it could be performed by different types of fixation tools such as the metallic screw with washer or suspension system, according to the preference of the surgeon.

An ideal anteroposterior and rotational stability, avoiding the medial compartment overconstraint, was achieved with the progressive fixation of POL in full knee extension combined with the MCL fixation in mid-flexion. Moreover, using this reconstruction, the double bundle remains in tension in all the ROM at the valgus stress test immediately postoperatively.

Discussion

The greatest benefit of this technical procedure is related to the sequence of the fixations of the double-bundle reconstruction of the POL and MCL that guarantees that POL has a good functionality in both full extension and mid-flexion, due to the semitendinosus sling below the semimembranosus tendon. Furthermore, the MCL bundle was tightened and fixated at 40° flexion and neutral rotation with gentle varus stress, as described previously in several studies [5, 14, 22].

Nowadays, the double-bundle technique is frequently used, and it has been described extensively by Kim et al. [14], Stannard et al. [22], Borden et al. [6], Yoshiya et al. [25], Lind et al. [16], Coobs et al. [7], and Wijdicks et al. [24].

The technique of Coobs and Wijdicks et al. [7, 24] is the only one that considers MCL and POL as two different structures with proper biomechanical functions during medial and posteromedial structure reconstruction. However, in their technique, we found poor regard to the strict relationship between the POL and the direct arm of the semimembranous tendon. This significant relationship is more considered in the techniques of Kim et al. [14] and Stannard et al. [22], which use the free end of the autogenous semitendinosus tendon to tension the direct arm of semimembranous tendon, while preserving the tibial attachment. In our opinion, the major limit of those techniques is that POL fixation in slight flexion can put at risk of medial overconstraint at full extension.

Most studies about MCL reconstructions in the literature are case series with heterogeneous study groups (with or without associated ligamentous injuries) and without any demonstration of one technique superiority [2, 5].

The limits of our technical procedure are the absence of a biomechanical test on the double-bundle reconstruction, and the clinical outcome at follow-up. A clinical study with a minimum follow-up of 2 years is needed to verify the effectiveness of this new procedure for MCL and POL reconstruction. A prospective study at our institution is ongoing at the moment.

Conclusions

An injury to the PMC needs to be treated with combined MCL and POL reconstruction. The usefulness of our technique of concomitant MCL and POL reconstruction is the semitendinosus sling and the POL fixation with the knee in full extension, respecting the biomechanics of this structure. This technique is easily reproducible and useful and restores the medial stability immediately after surgery.

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