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Case Report

Arthroscopic suture bracing of posterior cruciate ligament in a multiple ligament knee injury – A technical report

Jonas Scheck*, André Chakraborty, Gerald Zimmermann

Theresienkrankenhaus Mannheim, Dept. Unfallchirurgie und Sporttraumatologie, Bassermannstraße 1, 68165 Mannheim, Germany

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ABSTRACT

The optimum therapy of a torn PCL in multiligamental-injured knees is controversially discussed in literature. As conservative treatment and PCL reconstruction alone mostly lead to long-term immobilization, we performed a single stage PCL bracing with ACL reconstruction using ACL TightRopes® and Fiber-/TigerTapes® to accelerate back-to-sport after multiligamental knee injury with bicrucial tears. The brace consisted of two FiberTapes which were looped in an ACL TightRope and transosseously fixed with a Dog Bone-Button®. The ACL reconstruction was performed by a fourfolded semitendinosus graft in TightRope® technique. We chose an active rehabilitation-protocol with immediately allowed knee flexion to 90° in an ACL brace. This led to excellent results with resumption of sports after 6 months and good subjective and objective knee stability measured with a KT-1000. Our results hint that our method of bracing a torn PCL in multiligamental knee injuries may lead to faster rehabilitation with comparable knee stability.

Introduction

The posterior cruciate ligament, the strongest knee ligament, is crucial for posterior knee stabilization. Its tear resistance amounts up to 4000 N [1]. The PCL is known to consist of two bundles, namely the thicker anterolateral and the posteromedial bundle which both individually and collectively stabilize posterior tibial translation [2]. The much stronger ALB has its fan-shaped origin at the cranial lateral part of the medial femoral condyle and its more compact (hence appearing thinner) distal insertion point at the dorsal edge 1 cm below the tibial posterior intercondylar area. Both bundles act in synergy to resist posterior translation during knee-flexion and extension [2–5].

In 93% of knees, at least one meniscofemoral ligament, originating from the posterior horn of the lateral meniscus and inserting anterior (Humphrey ligament) and posterior (Wrisberg ligament) of the femoral PCL attachment-area can be found. This supports this posterior stabilization [6,7]. Due to this complex anatomy, PCL injuries are often associated with other intraarticular knee lacerations such as the dorsomedial or posterolateral capsular ligamentous complex causing a combined posterior instability [8].

PCL injuries are usually caused by strong dorsal shear stress of the lower leg against the femoral condyles. These circumstances are mostly found in traffic related accidents or sports injuries [10].

The correct diagnosis is made by interaction of physical examination, radiographic and MR imaging. Especially with the posterior drawer test, the physician can detect PCL tears with good sensitivity and specificity [8].

Standard X-ray images (a.p. and lateral) can exclude bony injury, whereas stress radiographs with positioning devices not only

Abbreviations: PCL, posterior cruciate ligament; ALB, anterolateral bundle; PMB, posteromedial bundle; MCL, medial collateral ligament; a.p., anterior posterior; STSD, side-to-side differences; LCL, lateral collateral ligament; PLC, posterolateral complex

* Corresponding author.
E-mail address: j.scheck@theresienkrankenhaus.de (J. Scheck).

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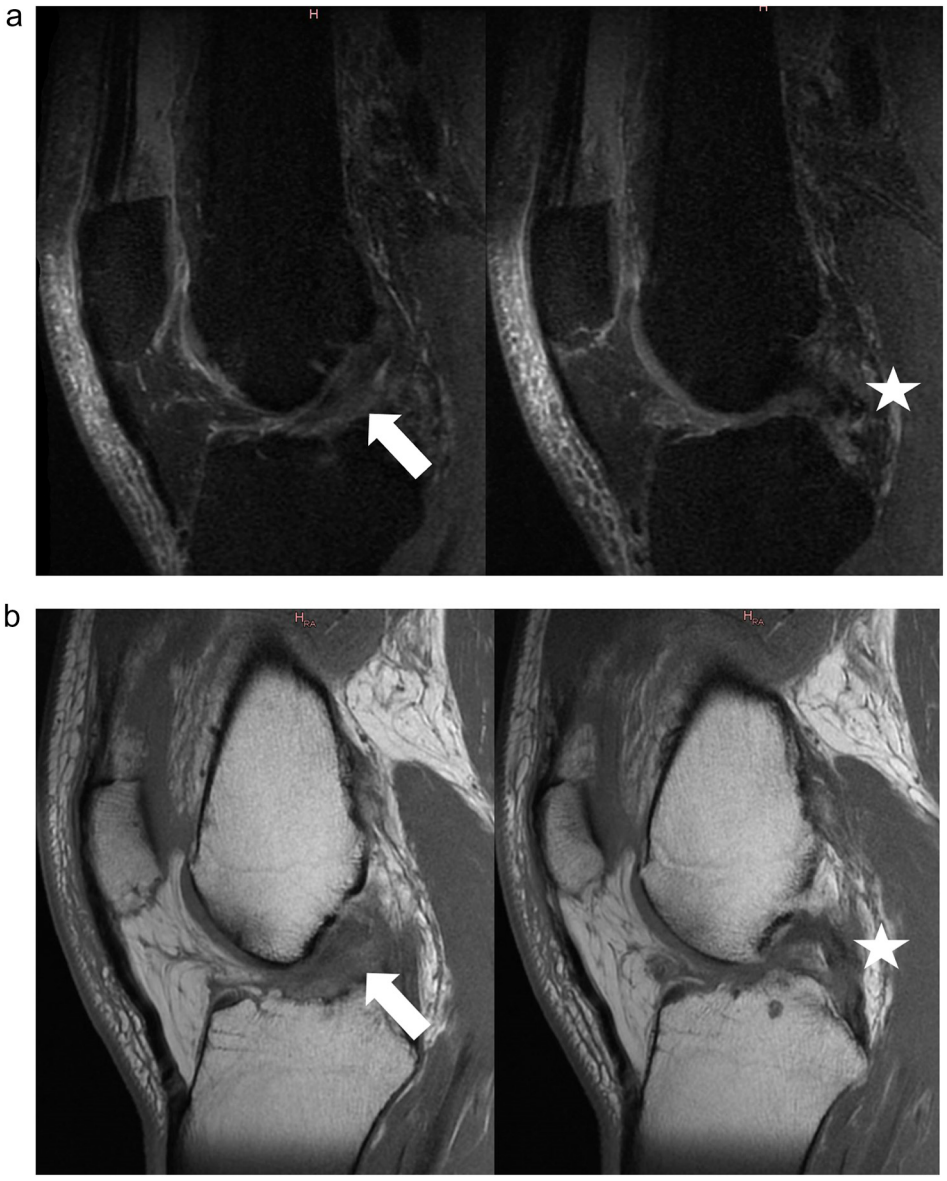

Fig. 1. a: Preoperative MRI scan PD FS cube sagittal with torn ACL (⟹) and PCL (☆).
b: Preoperative MRI Scan T1 FSE sagittal with torn ACL (⟹) and PCL (☆).

detect the posterior tibial translation but also quantify the posterior laxity [9,10]. MRI scans also can detect acute PCL tears, but in 60%, an apparent ligamentous continuity intraoperatively turns out to be torn. Therefore, Rodriguez et al. recommend to pay attention to abnormal intraligamental signal alternation on proton-density images and a-p increased width of the PCL in sagittal T2-weighted images [11]. Nevertheless, an MRI scan is recommended to exclude concomitant injuries (Fig. 1a, b).

In the past, non-surgical treatment was the therapy of choice for isolated PCL injuries. Many trials showed reasonably good long-term results of primary conservative therapy with PCL bracing, regarding the subjective and objective knee function [12–14].

As prospective trials don't show clear advantages neither for conservative nor surgical treatment of acute isolated PCL injuries, the decision tree for surgical or non-surgical therapy is often based on expert opinions. Though, a dorsal translation exceeding 10 mm in stress radiographs and multiligament injuries is discussed to require surgical therapy [15].

So far, there is no evidence based PCL tear rehabilitation protocol, neither for the nonoperative nor the postoperative management [16]. According to the guidelines of the German Association for Trauma Surgery (DGU), non-surgical treatment requires a knee-bracing in a PCL brace, which redresses the tibial posterior translation, for at least 12 weeks. For the first 6 weeks, the brace should be fixed in full extension, partial weight-bearing should be allowed. To remove the brace, a prone position and quadriceps muscle tension is mandatory [17]. This requires a high-level patient compliance, which is often missing in everyday practice.

In compliance with these particularly complex demands, a positive long-term result can be achieved with side-to-side differences

(STSD) of the distance between the injured and the intact knee ranging from 3.0–5.2 mm on KT-1000 [18]. Patel et al. showed a 90% subjective satisfaction rate after conservative treatment of isolated PCL tears [19].

Even though there's no increased rate of arthritis after conservative treatment, recent trials showed a better objective knee stability after surgical PCL reconstruction with average STSD ranging from 0.7–5.9 mm on KT-1000 [18]. Furthermore, surgical treatment allows a shorter and less strict rehabilitation which comes along with shorter injury lay-off and faster return to sports. As surgery is required in times of therapy failure after conservative treatment with long-term rehab protocol, an even further delayed back to sports is caused. Therefore, especially athletes benefit from an early surgical treatment.

Case description

We report on a 54 years old, male patient, in good health condition (no pre-existing illnesses, no long-term medication) who suffered from a combined injury of his left knee with ACL and PCL tear and proximal MCL tear. The trauma resulted from a football accident with an opponent falling against his fixed lower leg. The patient immediately showed up in our emergency room and complained of pain and a massive knee instability with his knee giving way.

Bony injuries were initially ruled out by X-ray and an MRI scan of the left knee was performed. By MRI scan, a totally torn ACL and PCL as well as an injured MCL was diagnosed. Associated, a bone bruise of the lateral tibial plateau and the medial femoral condyle was found. A corresponding intraarticular joint effusion, the lack of a firm end-point of anterior and posterior restrain and an increased anterior and posterior translation could be found in the clinical examination.

Due to the requested accelerated rehabilitation schedule after ACL reconstruction and the patient's expectations of a fast return to sports, an operative treatment of PCL by bracing in combination of an ACL semitendinosus autograft reconstruction was planned. Non-operative treatment was defined for the torn MCL.

11 days after trauma, surgery was performed under general anesthesia and standard preoperative antibiotics. The patient was placed in the supine position with a motorized knee positioning device and first, the increased posterior tibial translation was confirmed and compared to the opposite side by fluoroscopy. After closing the pneumatic tourniquet, anterolateral and anteromedial portals were created in typical positions.

Corresponding to the MRI findings, a totally thinned out ACL with proximal tear and a completely torn PCL were found. Furthermore, a 15 × 15 mm grade 3 cartilage damage of the medial femoral condyle was detected in the load-bearing area. To be able to target the notch with an instrument, a third portal through the patellar tendon was installed, the camera was positioned through a posteromedial portal. As a first step, the remaining fibers of the torn ACL were excised. The tibial marking hook (Tibial Anatomic Contour PCL Guide, Arthrex, Naples, FL, USA) was aligned and the over-the-back-hook was placed in direction of the fibers. The Drill sleeve was pushed against the lateral tibial head through a small incision at 80° and a borehole was drilled by a 6.0 sized FlipCutter® (Arthrex). Through a Jamshidi Needle (Medtronic, Memphis, Tennessee), a shuttle suture was inserted and ventrally diverted. For the femoral drill-hole, the camera was placed in the lateral portal, the femoral marking hook (Femoral PCL Marking Hook, Arthrex) was positioned at the femoral origin of the PCL and again through a skin incision, a tunnel was drilled at 75° by the 6.0 sized FlipCutter®. A femoral shuttle suture was ventrally transferred. The brace consisted of a FiberTape® and a TigerTape™ (both Arthrex), which both were connected to an ACL TightRope® (Arthrex). The TightRope was passed through the femoral canal and the button was pushed to the bone. After verifying the correct position of the button by fluoroscopy, the tapes were passed through the tibial tunnel and fixed by a Dog Bone™ Button (Arthrex). Under endoscopic control, the brace was slightly strained via the TightRope.

After confirming the brace position medially to the remaining PCL fibers, a four-strand semitendinosus autograft ACL reconstruction was performed using two ACL TightRopes. After 2 cm popliteal skin incision and incision of the fascia, the tendon was identified and stripped by an open (femoral) and a closed (tibial) semitendinosus stripper (Arthrex). The purged tendon was four-folded and knotted to 2 ACL TightRopes by using a FibreLoop Size 0 (Arthrex), so that a 6.2 cm long graft with a diameter of 9 mm was formed. The notch was cleaned and the femoral drill guide (Footprint Femoral ACL Guide, Arthrex) was positioned through the lateral portal at 105°. With a 9 mm FlipCutter, the femoral borehole was drilled antegrade throughout a small femoral skin incision, afterwards retrograde with flipped drill for 2,5 cm. For the tibial channel, the tibial drill guide was positioned through the medial portal at 60° and the tibial hole was drilled antegrade and then again reamed retrograde for 2,5 cm. The graft was pulled in and tensioned with fluoroscopically confirmed extraosseous buttons (Fig. 2). In the end, the definitive tension of both ACL transplant and PCL brace was adjusted.

Different rehabilitation protocol

Because of the braced and stabilized PCL, we chose an active rehabilitation protocol with immediately released range of motion between 0 and 90°. The only difference to our ACL reconstruction rehabilitation protocol was the prescribed non-weight bearing for 3 weeks. Even though we handled a multiligamental knee injury with reconstructed PCL, an ACL brace was adjusted in order to gain a faster knee flexion. After two weeks, muscle-building training in closed systems and ergometer exercises were allowed under physiotherapeutic supervision. Physical therapy was completed after 8 weeks and three months after surgery, free isokinetic muscle-building was permitted with return to all sports after 6 months except competitive situations (Table 1).

Results

The peri- and postoperative course was uneventful, the drainage tube was removed two days after surgery. We took an X-ray of

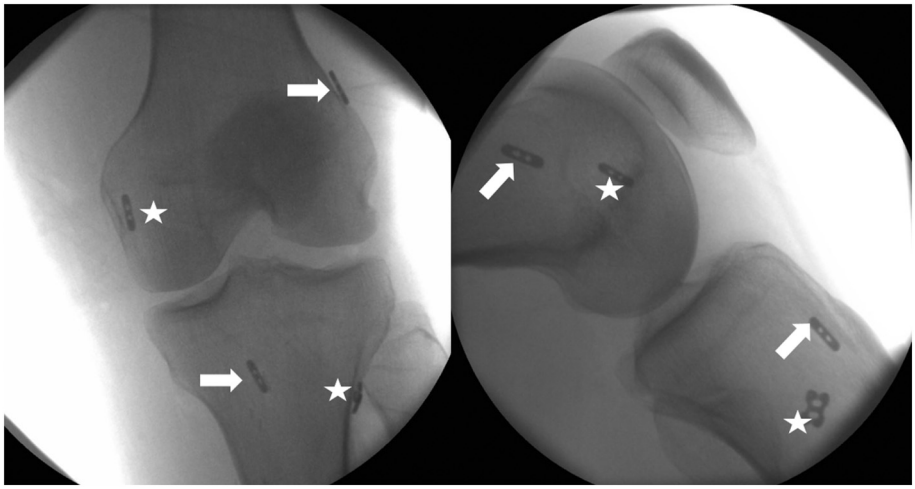

Fig. 2. Intraoperative fluoroscopy in lateral position with ACL (⟹) and PCL (☆) button location.

Table 1
Individual postoperative rehabilitation protocol.

Postoperative days 2 and 3
- Fitting a dynamic ACL brace
- CPM machine in settings 10 degrees extension and 60 degrees flexion
- Partial weight bearing with 20 kg with the ACL brace
- Quadriceps muscle training and active knee mobilization
- Electromyostimulation
Postoperative days 4 to 10
- Increasing range of motion to 0/0/90° for extension/flexion with the ACL brace
Postoperative days 11 to 20
- Increased dynamic muscle workout
- Free range of motion
- Swimming/Aqua jogging
Postoperative weeks 3 to 7
- Gradual transition to full weight bearing with the ACL brace
- Dynamometer-based exercises
- Coordination and stabilisation training
- Muscle-structure in closed systems
Postoperative weeks 8 to 12
- No further physiotherapy needed
- Independently work-outs
- Back to work
Postoperative month 6
- Unlimited back to sports

the knee to confirm the correct position of the buttons and 5 days after surgery, the patient was discharged.

Afterwards, high-frequency daily physiotherapy according to our protocol was implemented, and after 6 months, sportive activities were started with swimming. After 15 months, the patient resumed to play football and to go jogging without any limitations. The subjective knee stability was reported to be comparable to before, the patient did not feel pain or instability during sportive activities.

The postoperative knee stability was measured by the KT-1000 arthrometer 17 months after surgery. In repetitive measurements, the anterior tibial translation was +2 mm at 90° knee flexion on both knees, the posterior tibial translation was -1 mm for the concerned left and the right knee. At 20° knee flexion, the posterior tibial translation and the anterior tibial translation was same on both knees, too (−1,5 mm, +2,5 mm).

Discussion

Because of its position as a main stabilizer of the knee joint, a consistent treatment of PCL injuries is crucial. Besides surgical treatment of PCL tears, non-operative therapy plays a major role concerning this injury and can achieve good results. Conservative management comes along with protracted aftercare and long-term immobilization, causing conflicts particularly in combined injuries of ACL and PCL because of the different rehabilitation protocols. Even though there is no consistent evidence [16], non-operative treatment of PCL tears mostly comes along with long-term immobilization. In contrast, after ACL reconstruction, a progressive rehabilitation protocol with knee flexion and full weight bearing is important to achieve a good mobility of the joint [20]. Furthermore, especially after multiligament knee injuries, arthrofibrosis is a major complication, thus, an accelerated early-phase rehabilitation is crucial for these severe lesions [21]. Because a stable PCL is needed for this, we decided to stabilize the torn PCL.

Due to small case numbers and a heterogeneous collective, the therapy of multiligament knee injuries is subject of current research, neither the therapy regime nor the right timing for possible surgery is finally clarified [22]. Combined ACL and PCL injuries usually require surgery and mainly, an ACL reconstruction is recommended [23].

Regarding the ACL-surgery, we chose the “gold standard” of graft reconstruction. We selected the ipsilateral hamstring allograft.

The therapy of PCL tears in multiligament knee injuries is still discussed. Mygind-Klavsen et al. showed a long-term STSD of 2.7 mm in isolated PCL tears after reconstruction and 2.8 mm in combined PCL tears after reconstruction in a level 3 trial. Due to these good results, they generally recommended a surgical treatment of PCL tears [24]. Additionally, a non-operative treatment of PCL injuries with torn ACL in a PCL brace is contraindicated because of the missing ventral resistance. To reconstruct the PCL, only the contralateral hamstring tendon was an option, because patellar or quadriceps tendon graft would weaken the quadriceps femoris muscle as a PCL agonist [25]. As both sides hamstring tendons would have been used then, problems would occur in case of needed revision. Basically, PCL reconstruction mostly is performed by hamstring tendons, whereby - especially in case of co-injured LCL or PLC - contralateral tendons are preferred. Many authors are critical of quadriceps or patellar grafts as these tendons are functional PCL agonists [26]. In particular cases multidimensional corrective osteotomies may be necessary [27].

Especially in multiligamental knee injuries, a graft-saving procedure with conservation and reconstruction of the torn ligament is desirable. As ligament refixation or repair shows poor long-term results [28], the internal suture bracing of a torn PCL can be an option. Since the rupture was fresh, we decided in favor of one-stage suture bracing of the PCL with an ACL reconstruction. There are a few recent case reports that show the efficiency of suture tape augmentation of PCL injuries [29,30], but to the best of our knowledge there is no data of combined ACL and PCL tears with reconstruction of ACL and bracing of PCL. Basically, with suture augmentation of the PCL the question of the best graft for reconstruction is no longer required and more options will be available in case of a needed revision. Furthermore, the braced PCL allows a significantly more progressive rehabilitation protocol with likewise good stability than non-surgical treatment.

Conclusion

We could show, that internal bracing of an acute torn PCL in a multiligamental injured knee brings excellent mid-term results regarding stability and patient satisfaction, so that we implemented this method of PCL stabilization in acute multiligamental injured knees in our center.

Arthroscopic suture bracing of the PCL is a promising therapy option for multiligament knee injuries with accelerated back-to-sports because of earlier active flexion and excellent subjective and objective postoperative results with comparable stability in the KT 1000 measurement. These encouraging results possibly change also the mostly non-operative treatment of isolated PCL tears in the future.

To confirm this preliminary result, a prospective trial comparing PCL reconstruction and suture bracing in multiple ligament knee injuries is needed.

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