All inside transtibial arthroscopic posterior cruciate ligament reconstruction in skeletally immature: Surgical technique and a case report

F. Accadbled*, J. Knörr, J. Sales de Gauzy

Department of Paediatric Orthopaedic Surgery, Children Hospital, CHU de Toulouse, 330, avenue de Grande-Bretagne, 31059 Toulouse cedex 9, France

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Summary  Posterior cruciate ligament (PCL) tears are rare in children and may cause posterior instability of the knee. We present an original reconstruction technique. An 11-year-old boy sustained a PCL rupture. Despite initial immobilization followed by physiotherapy, he could not resume his previous sporting activities at the pre-injury level and complained of anterior knee pain. We performed an arthroscopic PCL reconstruction using a single bundle four-strand hamstring autograft. The femoral tunnel was drilled through the epiphysis and the tibial tunnel went through the physis under both arthroscopic and fluoroscopic control. The graft was secured using absorbable interference screws. At 2 years follow-up, the patient was asymptomatic and resumed sports at the same level as before the injury. Clinical examination was normal. There was no sign of growth disturbance. PCL injury is extremely rare in children. This original technique seemed appropriate in a symptomatic patient.

Level of evidence: IV.

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Introduction

Many ligamentous knee injuries are diagnosed every year in children, due to an increased participation in organized sports, improved imaging techniques and better awareness of their existence [1]. However, in substance tear of the posterior cruciate ligament (PCL) is very rare in children and its management remains poorly documented. We report the case of an athlete child with posterior instability of the knee for whom non-operative treatment had failed and who was successfully treated with an original all inside arthroscopic transphyseal reconstruction of the PCL. The patient and his parents were informed that data concerning the case would be submitted for publication and agreed to it.

Case report

An 11-year-old athlete boy sustained a direct blow onto the anterior aspect of his left proximal tibia while wrestling
with a schoolmate. Initial examination revealed a knee effusion and a false positive Lachman test. Radiographs of the knee were negative and MRI demonstrated a complete intrasubstance PCL tear (Fig. 1). Management consisted of a knee extension splint and limited weight bearing for 4 weeks followed by restricted activity in a functional brace and adequate physiotherapy for 3 months. The patient then gradually returned to sports at school but could not resume pivoting sports especially triple jump which he used to practice at the state level and complained of occasional left anterior knee pain. He was first referred to us 18 months after the injury, when he was 12 years and 4 months old. His subjective International Knee Documentation Comminges (IKDC) score was 67. Physical examination of the knee revealed reducible left posterior sag, no effusion, and a range of motion of 0° to 140° with pain in forced flexion. Left thigh perimeter outweighted the opposite side by 2 cm. Posterior drawer test at 70° of flexion was positive with a glide at the reverse pivot shift test. The one leg hop test was 10° increased for the injured knee compared with the opposite side at both 30° and 90° of flexion. The one leg hop test was 75% of the opposite side. Stress radiographs at 25° of flexion with 70° of posterior force revealed a side-to-side difference of 8 mm of tibial posterior shift of the affected knee compared to the opposite side (objective IKDC C). Long leg radiographs showed no leg length discrepancy or angular deformity. The patient weighed 40 kg for 152 cm. Puberty stage was graded Tanner II and bone age was 11 years and 6 months according to the Greulich and Pyle’s method. An MRI obtained at that time revealed no meniscal or chondral damage. Gait analysis demonstrated several slight anomalies including a 15° permanent anterior tilt of the pelvis, a prolonged left toe off phase as compared to the right and an inward deviation of the left step angle during the single stance phase. After extensive and repeated consultations with the patients and his parents, it was decided to proceed with a PCL reconstruction.

**Figure 1** Sagittal T1 weighted MRI showing a complete intrasubstance posterior cruciate ligament (PCL) tear. Open physis visible.

**Figure 2** Peroperative lateral image intensifier view. Transphyseal tibial guide wire aiming at the posterior cruciate ligament (PCL) footprint.

**Surgical technique**

The patient was installed supine, both legs hanging down with the left in a knee holder around a tourniquet. The image intensifier was set to provide peroperative true lateral views prior to the draping. The procedure began with a standard arthroscopy that revealed loose PCL fibers, which were spared. Semitendinosus and gracilis tendons were harvested and whip stitched in a standard fashion using size 2 Orthocord suture (DePuy Mitek, Raynham, Massachusetts) to obtain a 6.5 mm diameter 4-strand autograft. A posterior medial portal was created by an outside in technique to facilitate the tibial footprint preparation and a shoulder cannula was introduced. A PCL tibial aimper (Acufex, Smith & Nephew, Andover, Massachusetts) was set at 50° and positioned, targeting the PCL epiphyseal footprint, then a transphyseal guide wire was introduced under both arthroscopic and image intensifier guidance (Fig. 2). A 7 mm diameter tibial tunnel was drilled, a curette carefully protecting the posterior neurovascular structures. An epiphyseal femoral tunnel was then created using an outside in technique. A PCL femoral aimper was inserted through the anteromedial portal and placed in the center of the native PCL anterolateral bundle footprint. The guide wire was advanced through a small incision over the medial femoral condyle under lateral image intensifier guidance to avoid violating the distal femoral physis. A 7 mm tunnel was then drilled at low speed to prevent any thermal injury to the physis. The graft was passed in a retrograde fashion using a cord as a relay first into the tibia through the anterolateral portal, using a probe as a pulley, then into the femoral tunnel. The graft was secured first to the femur using a Milagro 7 × 23 mm bioabsorbable interference screw (DePuy Mitek, Raynham, Massachusetts), then it was tensioned and secured to the tibia in strong anterior drawer at 70° of flexion with an identical screw. Great care was taken to place the screw in a strict metaphyseal position so as not to bridge the proximal tibial physis. Immediate radiographs were obtained (Fig. 3).
Results

Postoperative care

The patient was placed in extension using a long leg cast for 6 weeks. At this time, a hinged knee brace was fitted for another 6 weeks and he started a rehabilitation program including passive range of motion and active extension exercises in the prone position. Weight bearing was gradually resumed to full 9 weeks after the surgery. Straight line jogging was started 6 months postoperatively and pivoting sports 9 months postoperatively.

Postoperative evaluation

The patient was examined 28 months after surgery, when he was 14 years and 8 months of age. He had returned to competitive athletics and handball, with confidence in his knee. His IKDC subjective score had been improved from 67 to 91. He was 163 cm tall (+11 cm) and weighted 54 kg. Examination revealed full range of motion with no side-to-side difference. There was no effusion or tenderness. There was no posterior tibial sag or posterior drawer, dial and reverse pivot shift tests were normal with no side-to-side difference. One leg hop test was identical to the unaffected side. Stress radiographs at 25° of flexion with 90 N of posterior force revealed a side-to-side difference of 2 mm of posterior shift of the tibia of the affected knee compared to the opposite side (objective IKDC A). Long leg radiographs showed no leg length discrepancy or angular deformity (Fig. 4). There was no deformity at the distal femur or the proximal tibia according to comparative true lateral radiographs. MRI scan confirmed integration of the tendon graft (Fig. 5). A gait analysis was obtained at latest follow-up and demonstrated complete correction of the above mentioned anomalies.

Discussion

PCL injuries are rare in the pediatric population with only a few cases reported. They are mostly chondro-osseous avulsion fractures of either the femoral or the tibial attachment [2,3] that represent the ligament’s weakest point [4]. Our review of the literature revealed only four PCL intra-substance tears [5–8]. The natural history of PCL tears in children is poorly documented although a non-operative approach is accepted, both because of a high healing potential and the risk of iatrogenic growth arrest in case of surgical reconstruction. However, bad long-term outcomes...
with progressive deterioration of the knee were reported. Five years after a complete midsubstance tear of the PCL sustained when he was 6 years old, a boy complained of anterior knee pain and looseness in his knee as he developed postero-lateral ligament laxity and a medial meniscus tear [5]. Anderson et al. reported on a case of posterolateral instability with pain, swelling and giving way episodes in a 13-year-old boy, 18 months after a PCL tear [6]. Using studies of the adult population, PCL insufficiency can cause degenerative changes of the patello-femoral and medial compartment of the knee [9,10]. Our athletic patient had a strong desire to return to pivoting sports, which he could not achieve, mostly due to a lack of confidence in his knee. The anomalies on the preoperative gait analysis are certainly difficult to interpret though we consider them relevant of altered knee kinematics, all the more that they disappeared at final follow-up. The risk/benefit ratio was thoroughly considered, namely the risk of iatrogenic physeal injury opposed to the goal to restore normal function and knee kinematics and potentially to prevent later degenerative changes. Satisfactory clinical and stability results after PCL reconstruction have been reported through relatively large series in adults [11]. However, such a procedure needs to be modified when dealing with a skeletally immature patient.

Anderson et al. first described in 2007 a double bundle PCL and posterolateral corner reconstruction technique using a metaphyseal non-aneontibial tunnel, which exposed to potential residual laxity [6]. A novel technique by Bovid et al. implied 10 mm diameter epiphyseal tunnels that raised the issue of avascular necrosis or epiphyseal fracture [8]. Warne et al. more recently added an all epiphyseal technique, which required preoperative repositioning of the patient into a prone position and dissection of the popliteal fossa [12]. All three above mentioned reconstruction types yielded good short-term outcomes in the corresponding case reports. The effects of drilling across open physis have been studied in animal models. The risk of growth disturbance is minimal provided the tunnel is filled with soft tissue material [13]. Tibial transphyseal anterior cruciate ligament reconstruction is safe and now widely adopted with good results in skeletally immature individuals [14,15]. We therefore opted for a transphyseal tibial tunnel that provided anatomic placement of the graft with a relatively simple, all inside procedure.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/jotsr.2012.11.017.

References

Transtibial arthroscopic posterior cruciate ligament reconstruction in adolescent


