CASE REPORT

Unusual case of a surgically treated ACL tear in a 4-year-old patient

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SUMMARY

Anterior cruciate ligament injury in children is an increasingly common disease. We report a rare case of surgical treatment of a 4-year-old patient who presented with an anterior cruciate ligament tear after a high-energy trauma followed by chronic spontaneous subluxation during knee flexion and extension. An extra-articular ligament reconstruction technique was performed and the child is clinically well 4 years after surgery. Historically, non-surgical treatment has been the main treatment option, however, the indication for surgical reconstruction is increasing as we better understand the histological characteristics of the immature skeleton.

BACKGROUND

Reported incidence of debilitating anterior cruciate ligament (ACL) injury in children has increased mainly because of their frequent participation in competitive sports associated with improved ACL diagnostic techniques.^{1–5} A torn ACL in a skeletally immature patient is still a dilemma for orthopaedic surgeons.^{1–3 5–7}

Non-operative treatment may include activity modification, bracing and structured rehabilitation, and it is the first treatment option for most orthopaedic surgeons. However, studies have shown poor clinical outcomes for these methods, with an increase in associated meniscal and chondral injuries, as well as a decreased number of patients returning to their previous athletic condition.^{1 5 6 8–12}

Surgical treatment with ligament reconstruction restores joint stability, decreasing associated injuries related to a chronic ACL tear.^{1 4 5 7 8 10 12} However, surgical reconstruction of the ACL with standard techniques for adult patients is not free of complications for skeletally immature patients. Of major concern is an iatrogenic injury to the growing physis of the femur and tibia when the surgeon drills a tunnel for the ligament graft. This injury could possibly result in asymmetric growing of the limb as well as angular deformity of the knee. In order to avoid this type of complication, an alternative reconstruction technique should be applied, depending on the patient's stage of physeal growth.^{1 4 5 10–12}

The Tanner sexual staging system is currently used to define patients' treatment strategy.^{2 4} Currently, young patients with immature or nearly mature skeletons (Tanner III and IV) are believed to be ready to undergo arthroscopic transphyseal ligament reconstruction.¹³ There is no consensus for patients at

Tanner stages I and II.^{2 14} A transepiphyseal ACL reconstruction procedure is recommended for Tanner stage II. Some authors, concerned about the technical difficulty of this procedure for Tanner stage I patients, prefer a physeal-sparing procedure.¹⁵ Clinical results of this procedure are good as well.^{4 16–19}

We report an unusual case of a 4-year-old patient (Tanner I) with a traumatic tear of the ACL with significant instability and voluntary dislocation of the knee, which underwent an extra-articular ligament reconstruction with iliotibial graft, and a 4-year clinical follow-up.

CASE PRESENTATION

A 4-year-old, 16 kg, 3'5" tall boy had a traumatic tibial fracture after a wardrobe fell onto his left knee in 2011. He was treated with pain management and casting at a different institution. Thirty days after treatment, he was free of pain, although he frequently reported knee instability during the year following treatment. Also, he could not run or play soccer due to a voluntary provocative knee subluxation, which he was able to perform (video 1).

Owing to an unsatisfactory result, the patient was referred to our service 1 year after the trauma, when a chronic ACL tear (table 1) was diagnosed after clinical evaluation and a MRI study (figure 1). There was no meniscal damage, nor were there chondral lesions or other associated injuries. The patient's bone-age was assessed through radiographic studies. A panoramic X-ray of his lower limbs detected no length discrepancies (figures 2A and 3A). He was classified as Tanner stage I.

Video 1 Spontaneous subluxation of the tibia over the femur.

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Table 1 Clinical evaluation of the knee before surgery, and 6 and 48 months after surgery

Test	Preoperative	6 months postoperative	48 months postoperative
Lachman	+3/3+	+1/3+	+1/3+
Anterior drawer	+3/3+	+1/3+	+1/3+
Pivot shift	+3/3+	Negative	Negative

TREATMENT

The patient underwent surgical reconstruction of the torn ACL using an extra-articular technique^{1 6 10 17 20} (video 2 and figure 4). The procedure started primarily with a standard arthroscopic evaluation of the knee joint (figure 5A). Next, a lateral approach was performed at the patients' thigh to dissect and resect the iliotibial band (figure 5B). This structure was detached at its middle and proximal portions (figure 5C) and stitched onto itself to prepare the ligament graft (figure 5D). The graft was passed from the lateral condyle to the medial condyle through the anteromedial arthroscopic portal (figure 5E). At the proximal anteromedial zone of the leg, a 2 cm incision was made to identify the point where the graft would be inserted (figure 5F). After stitching one end of the graft at the posterior zone of the lateral femoral condyle, the loose end of the graft, located at the anteromedial approach, was pulled with tweezers, bypassing the intercondyle notch diving into the joint heading to the proximal zone of the tibia. The loose end of the graft was then fixed distal to the proximal tibial physis through anchor stitches (figure 5G). The final aspect of the new reconstructed ligament is shown in figure 5H. Final aspect of medial skin wounds is shown in figure 5I (video 3). The patient had postoperative brace immobilisation for

Figure 1 MR of the left knee: preoperative sagittal and axial views. Complete chronic tear of the anterior cruciate ligament (arrow).

Figure 2 Front and lateral radiographs of patient's skeletally immature left knee before (A) and 6 months after (B) surgery.

Figure 3 Lower limb radiographic scan before surgery (A) showing no limb discrepancy. Four years after surgery, there was a 10 mm shortening of the right knee.

6 weeks followed by physical therapy. At week 8, he had full knee extension and 90° flexion.

OUTCOME AND FOLLOW-UP

Six months after surgery, when his physical rehabilitation was completed, the patient was asymptomatic and able to perform his daily activities, and he was also back to sports. Clinical evaluation showed a knee with almost the same function parameters as the non-injured one (table 1). The patient could no longer voluntarily subluxate his knee as before. Furthermore, radiographic studies showed no bone abnormalities (figure 2B) and MRI showed a newly reconstructed ligament with good positioning (figure 6A, B).

Video 2 Preoperative clinical evaluation: anterior drawer test of the knee, Lachman manoeuvre, pivot-shift test and active quadriceps contraction test.

Figure 4 Illustrative surgical technique (Kocher)—physeal sparing, and combined intra-articular and extra-articular reconstruction with usage of an autogenous iliotibial band for prepubescent patients.

Four years after surgery, the patient was still asymptomatic, with normal knee range of motion on both sides, and he was free of pain and had no instability ([video 4](#)). Clinical evaluation of the operated knee showed no abnormalities ([table 1](#)). Otherwise, a lower limb scan showed a 10 mm lengthening of the left (556 mm—femur 312 mm/tibia 244 mm) compared to the right side (546 mm—femur 303 mm/tibia 243 mm; [figure 3B](#)). A MRI was performed and ligament aspect was horizontal

and thickened, similar to the earlier MRI performed 6 months after surgery ([figure 6C, D](#)).

DISCUSSION

This is a unique study describing a 4-year-old patient surgically treated for an ACL injury. Although there is no evidence in the literature for the best treatment, this report justifies its treatment decisions based on reason, and explains why a 4-year-old patient had surgery for an ACL tear. It is known that ACL tears are a frequent injury suffered by athletes. There has been an increase in the incidence of this type of injury, especially in the younger population, since a lot of different sports modalities are now more popular and professionalised.^{3 4} However, skeletally immature patients have unique histological and physiological characteristics in their knees, making treatment requirements for their lesions different from those for similarly injured adults.^{4 6}

For many years, we believed that non-surgical treatment was the best option for children and adolescents with an ACL tear, focusing on muscle strengthening with rehabilitation and keeping the patient away from sports activities. Surgical ligament reconstruction was considered when patients were older and skeletally mature.^{4 5 8 12} Nevertheless, with a better understanding of children's knee physiology, this patient population was categorised according to the Tanners classification. This sexual character development scale is correlated with bone growing velocity, and treatment can be decided based on patients' Tanner stage.¹³

Figure 5 Surgical procedure aspect of an extra-articular anterior cruciate ligament (ACL) reconstruction on the left knee (A–I). (A) Arthroscopic visualisation of the torn ACL. (B) Lateral approach to the thigh with visualisation of the iliotibial band. (C) Isolation of the middle third of the iliotibial band. (D) Proximal detachment of the iliotibial band graft maintaining its distal insertion to Gerdy's tubercle. (E) Preparation of the graft. (F) Anteromedial proximal incision on the leg. (G) Graft is passed over-the-top, intra-articular from lateral to medial. (H) Arthroscopic view of the new-ligament. (I) Clinical evaluation with proved stability of the knee.

Video 3 Surgical procedure. Arthroscopic view of the anterior cruciate ligament injury. Lateral approach to the thigh. Identification of the fascia lata (iliotibial band). Proximal graft detachment. Tubulisation of the graft. Passing the graft medial to lateral. Anteromedial approach to the leg/intra-articular graft passage. Arthroscopic view of the graft. Graft anchor fixation distal to the physal plate. Lachman test, anterior drawer test and pivot-shift test.

Video 4 Postoperative clinical evaluation 48 months after surgery: anterior drawer test, Lachman manoeuvre, pivot-shift test and active quadriceps contraction test.

A major complication from surgical treatment for an ACL tear in the young population results from physal perforation and damage when bone tunnels are drilled for graft positioning. However, studies report that patients on Tanner stages III or IV are usually not affected to a great degree on their final growth by this intervention. Based on these results, transphysal ACL reconstruction may be indicated for these patients.

Patients on early Tanner stages (I or II) still have significant remaining bone growth, and a physal injury at this point would result in a higher risk of limb growing discrepancies. Currently, the transepiphyseal ligament reconstruction technique is becoming more common for early-staged Tanner patients. Although it is a more time consuming and skilful technique, ligament reconstruction without physal injury is possible and results are more

anatomic than standard extra-articular reconstruction techniques.^{6 10 12 16 17 19–21} Nevertheless, on an unusual Tanner I patient with an ACL tear, such as the boy in this report, epiphysis is still underdeveloped and the transepiphyseal technique is highly complex and not always performable.^{4 12 18 19}

Although unusual and rarely mentioned in the literature, ACL injuries in children are mostly seen at 8–12 years of age.²² Our patient was only 4 years old at the time of injury, making it almost impossible to access his epiphysis; also, it is a challenge to keep patients of this age less active in their routine activities. Our patient had a direct trauma to his left knee, which caused an anterior subluxation of the tibia leading to an ACL tear. There is no consensus on how to treat a patient with this type of injury at this age. Although non-surgical treatment is initially preferred for most cases, owing to the difficulty of restricting physical activity in our young patient, waiting for muscle-bone development for future definitive treatment was not a feasible option. Furthermore, knee instability resulting in eventual falls,

Figure 6 MR of the left knee: Sagittal and axial views 6 (A and B) and 48 (C and D) months after surgery. Red arrow—ligament graft 6 months after surgery.

pain after physical activities and significant spontaneous joint subluxation leading to probable associated injuries were all considered, resulting in the decision for surgical extra-articular ligament reconstruction using the patient's iliotibial band as a graft. For this unique case, the treatment decision was correct, since, even without anatomical ACL reconstruction, the patient had and excellent clinical outcome. Imaging studies and clinical evaluation controls 6 months and 4 years after surgery showed no more falls, no pain and no subluxation. No associated injuries in the knee were diagnosed, either. We believe that even for skeletally immature patients with an ACL tear, surgical ligament reconstruction should be considered.

Learning points

- ▶ Even in the younger patient with anterior cruciate ligament injury, the possibility of reconstruction to avoid future knee problems can be considered.
- ▶ There were no major complications 4 years after reconstruction of the patient's knee and leg.
- ▶ The functional results were satisfactory 4 years after reconstruction.
- ▶ There were no limitations in daily activities.

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Contributors DCA wrote and documented the case study. SC and AB examined and supplied the case data. MC was the orthopaedic surgeon who conducted the surgery.

Competing interests None declared.

Patient consent Obtained.

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