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Short communication

Living related donor allograft for revision anterior cruciate ligament reconstruction in a child: A case report ☆

András Tállay [a,*], Mui Hong Lim [a], Hayden G. Morris [b]

[a] The Melbourne Knee Fellowship, Melbourne, Australia
[b] The Park Clinic, Melbourne, Australia

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Abstract

Revision ACL reconstruction poses several challenges for the surgeon in terms of the timing of surgery and the limited graft choices. To our knowledge, there is currently no published data with regards to revision ACL reconstruction in a child. We describe the case of a 12-year-old girl who had a re-injury 4.5 months after her index primary ACL reconstruction at the age of 11 years. She sustained a repeat injury to the reconstructed knee following a road traffic accident and developed significant instability despite an intensive rehabilitation program. After careful consideration of the available graft materials – known all the advantages and disadvantages of the autografts, allografts and synthetic materials – we decided to use the patient's mother's hamstrings as a graft. The parents of our patient refused the use of allograft and synthetic materials. We discuss our management of this case, the reasons for our revision graft choice, and the theoretical disadvantages of some of the alternative graft choices available in this scenario. We believe in such cases, performing ACL revision with a donor graft of the patient's mother could be good alternative to allografts or synthetic grafts.

Keywords: ACL; Revision; Child; Hamstring; Living related donor allograft

1. Introduction

The role for anterior cruciate ligament (ACL) reconstruction in children is much discussed and debated [36]. The main goal of ACL reconstruction in children is to restore knee stability without causing growth plate arrest, leg-length discrepancy, or angular deformity. The timing of surgery, graft selection, type of fixation device and surgical technique are areas of discussion [15,35]. Given the poor natural history with regard to progressive meniscal and chondral damage, the current consensus is to proceed with early reconstruction [25,36]. One of the main concerns is the violation of the growth plate with tunnel drilling in intra-articular reconstruction. However, studies have shown that drilling across the growth plate does not cause growth arrest [15,23]. The physis should not be crossed with either screw or bone block. Therefore soft tissue grafts, in particular the hamstring tendons are the graft of choice. Suspensory fixation devices are recommended for this group of patients. With the increasing number of primary ACL reconstructions in younger patients [6,8,28], one needs to anticipate the need for revision ACL reconstruction in these patients [4,27]. Revision ACL reconstruction poses several challenges for the surgeon in terms of the timing of surgery and the limited graft choices. Based on knowledge, there is currently no published data with regards to revision ACL reconstruction in a child.

We describe the case of a 12-year-old school girl who had a re-injury 4.5 months after her index primary ACL reconstruction at the age of 11 years. She sustained a repeat injury to the reconstructed knee following a road traffic accident and developed significant instability despite an intensive rehabilitation program. Our goals of her revision ACL surgery were to stabilize the knee so as to prevent secondary damage to the

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* Corresponding author.
E-mail address: tallay@t-online.hu (A. Tállay).

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articular cartilage and menisci, and minimize the functional morbidity. Based on our knowledge, currently there is no published study on the use of a living related donor allograft for revision ACL reconstruction. The considerations of the various graft options will be presented and discussed.

2. Case report

A 12 year-old girl who sustained a repeat ACL injury of a previously reconstructed knee and underwent revision ACL reconstruction using living related donor hamstring allograft. The index primary ACL reconstruction was performed at 11 years of age. Arthroscopic intra-articular reconstruction was performed with an ipsilateral 6 mm diameter quadrupled hamstring autograft. Graft fixation was achieved by a continuous loop Endobutton ® (Smith and Nephew Endoscopy, Andover, MA) over the femoral end and bone staple over the tibial end. Post-operative recovery and rehabilitation were uneventful.

Four months after the index operation, the patient represented following a motorbike injury with knee pain and swelling. Clinical examination revealed grade 2 Lachman's, grade 2 anterior drawer and grade 3 pivot shift consistent with an acute ACL graft disruption. Her Tanner staging at the time of the revision surgery remained unchanged at Stage 1. Arthroscopic examination revealed an acute disruption of the index ACL graft and a displaced bucket handle tear of the posterior horn of the lateral meniscus, which was repaired with two oblique pediosutures. The knee was placed in a brace.

On subsequent follow-ups, the patient complained of increasing instability affecting her activities despite intensive physiotherapy. At 9 months after her repeat injury, she was found to have significant quadriceps atrophy and knee instability (3+ Lachman's and anterior drawer, 2+ pivot shift test) results.

Further treatment options were discussed with the patient and her parents. In view of the debilitating instability with non operative management of bracing, physiotherapy and decreased activity level, surgical reconstruction was recommended. The choice of graft was discussed. These include the following:

1) Contra lateral hamstring autograft. Her initial hamstring graft was a relatively small (6 mm) diameter and given her severe instability it was felt to be inadequate.
2) Bone patellar tendon bone graft was not appropriate given the presence of open epiphyses and the potential of growth arrest with the use of bone blocks.
3) Allograft or synthetic graft. The parents decided not to take the risks of disease transmission or foreign body synovitis.

It was proposed that one of the parents would consider donating the hamstring tendons for reconstruction. The patient's mother having a low demand lifestyle agreed to donate her hamstring tendons. Before taking the final decision for using living related donor allograft, we reviewed the literature carefully, counseled the mother about the possible risks, morbidity, rehabilitation, expectations. We performed preoperative blood tests, for blood type and disease screening (Hepatitis A and B, HIV, and Syphilis). We examined the mother's knee joint, her hamstring tendons, and skin.

On the day of surgery, the semitendinosus and gracilis tendons were harvested from the patient's 43 year-old mother under general anesthesia with antibiotic prophylaxis. The ACL graft was prepared and measured 8 mm on the femoral side and 8 mm on the tibial side. After the routine skin closure the mother was sent to the recovery. The graft was wrapped in sterile moist gauze and placed in a sterile container. The operating theatre was then cleaned and prepared for the next case.

Following the harvest of the graft, the patient underwent general anesthesia in the same operating theatre for the revision ACL reconstruction. The arthroscopic examination demonstrated the complete disruption of the ACL graft. The lateral meniscus had healed. The intercondylar notch was then prepared using arthroscopic shaver clearing the lateral wall and posterior aspect of the notch to the over the top position. The knee was then flexed to a maximum of 140° and 8 × 35 mm femoral tunnel was drilled over a guide wire via the anteromedial (AM) portal at 10.30 position. PCL impingement was checked. The entrance to the tunnel was then smoothed with the hemispherical rasp to remove any sharp edges. The knee was then placed in the 90° flexion. An 8 mm tibial tunnel was then drilled over a guide wire exiting at the point of insertion of the native ACL with the aid of a tibial guide. The graft was anchored over the femoral end with a 20 mm continuous loop endobutton and tibial fixation was achieved with a 7 mm diameter, 25 mm length hydroxyapatite bioabsorable screw reinforced with a tibial staple. For choosing the length of the screw in children with open growth plate, we routinely measure under endoscopic control the length of the bony tibial tunnel to avoid placing the screw into the growth plate. The growth plate is visualized as a distinct pale area compared to the surrounding metaphyseal bone (Fig. 1). The

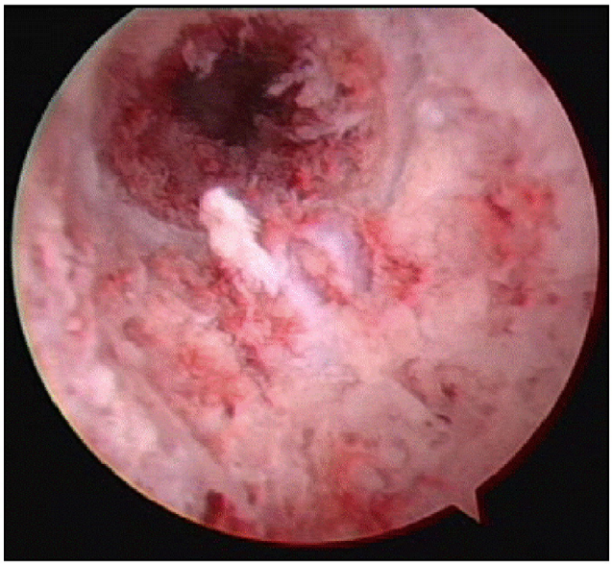

Fig. 1. Endoscopic picture of the tibial tunnel. The physeal plate is visible as a separate area in epiphysis.

Fig. 2. MRI scan 4 month post-operative illustrating the position and the incorporation of the bone tendon interface.

knee was then put through a range of movement to ensure that full extension is achieved post graft fixation.

Post-operative recovery was uneventful. Immediate weight bearing as tolerated and a full range of motion were allowed. The patient underwent a supervised rehabilitation program. At the latest follow-up at 7 months post operation, both the patient and her mother were pain free with a full range of movement. The patient is currently brace free, and her knee function is essentially normal. Her follow-up MRI scans showed excellent graft incorporation at 4 months (Fig. 2).

3. Discussion

The need for ACL reconstruction in children is still a matter of debate [2,5]. Current literature recommends early reconstruction due to the poor natural history with regard to progressive meniscal damage and advanced degenerative changes [16] and also poor results associated with conservative treatment [1,2,24,36]. The results of the operative management are superior to non operative management [34]. Some authors recommend diagnostic arthroscopy and evaluation under anesthesia to take a decision for ACL reconstruction in children [22]. For a skeletally immature patient, apart from non surgical management, surgical reconstruction has to be considered in a patient with persistent instability. Assessment of skeletal maturity is critical in determining the timing of surgery and graft selection. The clinical markers include skeletal age, Tanner stage, onset of menses, family member height, growth spurt, recent change in foot size and growth charts [16,28,35].

Our goals of her revision ACL surgery were to stabilize the knee so as to prevent secondary damage to the articular cartilage and menisci, and minimize the functional morbidity. The case management and the considerations for the graft choice for this young patient requiring a revision ACL reconstruction will be discussed. This case report illustrates a problem that arises when a young patient cannot provide good quality autograft for her ACL revision.

For our patient, non surgical management with bracing and lifestyle modification was not successful due to persistent instability limiting her daily lifestyle. Extra-articular ACL reconstruction has been described and performed for skeletally immature patients with the aim of restoring knee stability and averting the risks of growth disturbances due to violation of the growth plate in intra-articular reconstruction technique. This technique is not preferred due to the poor results, reported in various studies [7,9,12,21]. Intra-articular ACL reconstruction is currently the recommended technique with good clinical results [14,15,23]. The concern of growth disturbances due to growth plate violation had been addressed by various authors [4,18,19]. Current evidence has demonstrated that tunnel drilling does not result in significant growth disturbances [32]. Keeping in mind the patient's age, persistent knee instability and limitation of activities, the recommended treatment was a revision ACL reconstruction using soft tissue graft. The types of graft in revision ACL reconstruction are varied. The options available are as follows:

a. Contralateral hamstring tendon autograft. From the index reconstruction, the patient had a relatively small diameter graft of 6 mm. In addition, the patient is also noted to have increased objective ligamentous laxity; therefore, the use of the autograft was excluded. Furthermore the patient and her parents declined the use of contralateral autograft.
b. Bone patellar tendon bone graft. For revision ACL surgeries, bony tendon grafts are widely used with acceptable results [13]. However, this graft is contraindicated in skeletally immature patient due to the potential of the bone block causing premature physeal fusion and resulting in growth disturbances [11].
c. Cadaveric allograft. The use of cadaveric allograft has been recommended for revision surgery and in multi-ligament reconstructions [3,30]. It minimizes donor site morbidity and avoids further weakening of the knee joint [17,29]. However; an allograft does have potential problems of disease transmission [10]. It has also been shown to have physiological differences from the autografts in terms of slower revascularization, recollagenization and suboptimal healing as suggested by immunogenic studies. This would have been the graft of choice for this patient. However, the patient and parents declined this option in view of the potential disadvantages.
d. Synthetic graft. Synthetic graft has been used in selected patients for ACL reconstruction. To enhance the repopularisation of the graft by native soft tissue, it is essential that the graft is inserted within the native ACL stump to serve as strut augmentation. In our patient, there was minimal soft tissue stump remaining, therefore the use of synthetic graft was excluded. The patient and her parents were also not agreeable for this option due to risk of foreign body synovitis.
e. Living related donor allograft. The living related donation of solid organs such as liver and kidney has been practiced in

transplantation surgery with good success [5,26,31]. To our knowledge, the use of living related allograft has not been previously published for ACL revision surgery. The main advantages are bigger graft size and a fresh allograft. As well documented in the literature, tendons are not immunogenic; there is no need for special immune compatibility tests [33]. The fresh allograft biomechanical properties will not be degraded as a result of irradiation and freezing in the process of cadaveric allograft preparation. This new and radical option was explored with the patient and parents. After much deliberation, the patient's mother's hamstring tendon was selected as the graft for the revision ACL reconstruction. There was no need for our patient of a two staged revision [20], because of the small diameter primary tunnels.

Because of her early re-injury after the primary reconstruction, we were not able to evaluate her post-operative IKDC and Tegner scores.

With the increasing number of primary ACL reconstructions in younger patients [6,8,28], one needs to anticipate the need for revision ACL reconstruction in these patients. Unique problems are presented in the child that include open epiphyses, graft selection and fixation techniques. We have presented the case of a skeletally immature who presents with the need for revision ACL reconstruction, the considerations in graft selection and the use of a living related donor allograft for ACL reconstruction.

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