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Functional outcome after transphyseal anterior cruciate ligament reconstruction in young patients with open growth plates

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ABSTRACT

Background: This study evaluates sports ability, rotational laxity and potential growth changes in children after transphyseal ACL reconstruction with metaphyseal fixation technique, considering physis biology by placing drill holes vertically in the femoral anatomic origin in order to reduce volumetric injury to the physis.
Methods: In this retrospective trial of 42 patients data were collected. Thirty-seven were reviewed measuring rotational laxity and anteroposterior tibial translation using the Laxitester (ORTEMA Sport Protection, Markgroeningen, Germany) and the KT1000. Clinical examination was evaluated with the IKDC 2000 knee examination form. Leg axis was determined with digital photography and leg length was assessed clinically. Sports ability was assessed with questionnaires including subjective IKDC, Tegner Activity Scale, Activity Rating Scale and a questionnaire on sports and level of sports.
Results: Mean follow-up was 24.9 months. Mean age at surgery was 13.2 years in boys and 13.1 years in girls. IKDC 2000 grading was A or B in 28 patients and C in nine patients. Significant increased anterior tibial translation was observed in neutral position and in external tibia rotation. No growth abnormalities were seen. Fifty-seven percent of the patients were able to participate in competitive sports at follow-up.
Conclusion: Transphyseal ACL reconstruction with metaphyseal fixation in children with open growth plates can be done with low risk of growth changes. Return to competitive sports is possible although low rotational laxity still exists.
Level of evidence: IV.

1. Introduction

Intraligamentous anterior cruciate ligament (ACL) tears cause a dilemma for the patient as well as for the physician: On the one hand, a delay of surgical treatment until physeal closure includes the risk of eventual prearthrotic damage caused by a

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persisting unstable knee. In addition to reported meniscal and cartilage injuries, patients treated conservatively, usually are not able to return to their preinjury activity levels [1–5].

On the other hand, contemporary ACL reconstruction can lead to growth disturbances by harming the open growth plates with both growth arrest as well as overgrowth [6–9]. Nevertheless, recent studies underline the low risk of growth changes following transphyseal ACL reconstruction [10–13] and report only on five of 43 immature patients demonstrating a magnetic resonance imaging (MRI)-based focal physeal disruption which did not cause clinically apparent growth disturbance [14]. For minimizing the risk of growth disturbances some authors recommend reducing volumetric damage to the physis by placing vertical drill holes across the growth plates especially at the femur while performing a transphyseal ACL reconstruction [15]. But how such a vertical placed tunnel at the femur influences the rotational laxity in children has not been described yet [16].

This led us to the following questions to be answered: Is a transphyseal ACL reconstruction able to restore a stable knee, especially in rotation of the lower limb, comparable to the healthy knee? Does a transphyseal reconstruction with metaphyseal fixation technique lead to growth abnormalities? Can children return to their preinjury sporting level after transphyseal ACL reconstruction?

In our current retrospective study we are describing the functional outcome of transphyseal ACL reconstruction in skeletally immature patients with hamstring grafts and metaphyseal fixation. We hypothesised that the affected knee would show equal stability, no growth disturbances, and patients would have good results in return to sport.

2. Methods

This study was authorised by the responsible ethics committee, reference code: 69/15s.

2.1. Patients' data and selection

Between October 2006 and April 2010 in total 42 (28 males, 14 females) young patients with radiological open physes received transphyseal ACL reconstruction in a single-bundle technique with hamstring grafts and metaphyseal fixation. Physeal growth remaining was identified according to Prince et al. by classifying the cartilage sign of the physis in the T2 weighted magnetic resonance imaging (MRI).

Three patients had a rerupture, each because of a new distorsional trauma. One patient suffered a new torsional trauma while playing handball at nine months after initial reconstruction. One patient got reinjured after seven months while playing burning ball (game similar to baseball). One patient got reinjured in school sports. Two patients with ACL reconstruction on the contralateral knee could not be included in the survey. So 37 patients were retrospectively examined. From these 20 patients showed cartilage signal intensity present throughout the physis as complete open physes and 17 discontinuous cartilage signal intensity as partially open physes [17].

2.2. Surgical data and technique

All patients underwent full arthroscopic surgical treatment with a single-bundle reconstruction and metaphyseal fixation by highly specialised knee orthopaedic surgeons. Additional medial meniscus surgery was needed eight times, at the lateral meniscus 11 times and one time both. Meniscal surgery included seven refixations and 14 partial resections.

As transplants hamstring tendon autografts were used. Femoral drill holes were placed anatomically closely to the border of the posterolateral bundle insertion at the anteromedial bundle insertion site to gain more off-set to the perichondral structures of the physes [18,19] (Figure 10). Both tunnels were drilled more vertically to reduce volumetric damage to the physes [15]. Femoral fixation was performed metaphyseally with Endobutton (Smith & Nephew, Andover, MA; n = 21), Rigidfix pins (Johnson & Johnson Medical GmbH, DePuy Mitek Division, Norderstedt, Germany); n = 17) or bioabsorbable interference screws (Arthrex, Naples, FL, USA; n = 4). In the four cases of femoral screw fixation, the screws were placed beyond the growth plate, so that no hardware was located at the level of the physis. At the tibia, the drillholes were positioned more vertically. The tibial fixation of the graft was achieved using a bioabsorbable interference screw below the physis (n = 42). Overall, the aim was to minimise the cross section of the drillholes at the level of the physis and to place the femoral and tibial tunnel apertures anatomically.

2.3. Clinical scoring

At the time of follow-up, the patients were asked for their overall satisfaction and if they would undergo surgery again. The pain was quantified with the Visual Analogue Scale (VAS) [20]. In addition to the International Knee Documentation Committee (IKDC) subjective score [21], the Lysholm Score [22] and the Tegner Activity Scale [23], two more sports specific questionnaires were utilised: the Activity Rating Scale by Marx et al. [24] and the Sports and Activity Questionnaire [25] which evaluates the different disciplines of sports and the level of sports activity (high end level, superior level, competitive level, recreational level, no considerable activity).

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