



Journal club: 13 June 2013

Chairman: Mr A Ajuied & Mr A Davies

Convener: Mr I Findlay

Guy's and St. Thomas' Hospitals NHS Trust

Theme: Paediatric Anterior Cruciate Ligament Reconstruction

1. **Aichroth PM, Patel DV, Zorilla P.** The natural history and treatment of rupture of the anterior cruciate ligament in children and adolescents: a prospective review. *J Bone Joint Surg (Br)* 2002; 84-B:38-41.

Reviewer: Miss J Lane

Background

Acute anterior cruciate ligament (ACL) injuries in children and adolescents have traditionally been treated conservatively due to the risk of growth arrest with reconstructive surgery. These researchers had seen poor outcomes with conservative management in their own practice, and operative management of this cohort had already been described in the literature as successful.

Aims

The group aimed to evaluate the role of surgical reconstruction using a 4 strand hamstring graft in the management of acute ACL injuries in children and adolescents through the analysis of prospectively collected data. This was then compared with non-operative management used in a previous prospectively followed cohort.

Methods

I believe this study is attempting to be a prospective study providing level 3b evidence. However, this study is actually level 4 evidence; a retrospective analysis of a case series with prospectively collected data. It compares 60 non-operatively managed cases between 1980 and 1990 and 45 cases managed with surgical reconstruction (47 ACL reconstructions) occurring from 1990 onwards. Reconstruction was undertaken using a 4 strand hamstring graft with femoral and tibial anchors placed away from physes as previously published. Patients were compared pre- and post-operatively using Lachman and pivot shift tests, and outcomes were also measured according to the International Knee Documentation Committee (IKDC) subjective outcome scoring in the surgical group. The outcome of patients managed non-operatively was determined by comparing Lysholm score and Tegner activity level at initial review and follow up, and by radiological examination of joint degeneration at follow up.

Results

Of the 60 children managed non-operatively, 33 were prospectively followed. The mean age in the non operative group was 12.5 years (range 11-15) compared with 13 for the surgical group (range

11-15). Mean follow up was 72 months (range 36-144) for those non-operatively managed versus 49 months (range 12-96) in the surgical group. Pubertal status was only recorded for the surgical group. All cases were graded as Lachman and pivot-shift test 2 or 3 irrespective of group. Data was only collected for the non operative group pre-operatively, and no raw data was given for the surgical group pre-operatively. At follow up in the surgical group 3 patients were assigned pivot-shift grade 3, 2 grade 2, 15 grade 1 and 27 grade 0; 3 patients were assigned Lachman grade 3, 8 grade 2, 20 grade 1 and 16 grade 0.

In the non-operative group the initial mean Lysholm score of 78.6 (range 54-93) compared with 52.4 (30-83) at follow up. Mean Tegner activity level also decreased at follow up to 4.2 (2-6) from 6.7 at initial review (4-9). Scores were not taken for those in the surgical group.

IKDC scores at follow up in the surgical group were grade A 21 (45%); B 15 (32%); C 8(17%); D 3 (6%). IKDC scoring did not occur in the non-operative group.

In the non-operative group 23 patients had radiological evidence of the Fairbank sign, 3 had a narrowed joint space and 4 had major osteophytes at follow up. No radiological follow up occurred in the surgical group.

No statistical analysis was undertaken.

Paper's Conclusions

ACL injuries are an increasingly common injury in children and adolescents, and conservative management produces unfavourable results. This technique minimises injury to the epiphyseal plate, and generated a good result in 75% of patients. This study concludes that ACL reconstruction in children does not have the good outcomes seen in adults.

Appraisal

It is difficult to draw objective conclusions from this study due to the lack of uniform outcome measures used between the non-operative and surgical groups. There is a large difference in time to follow up between the groups, and it is also difficult to confirm that the groups were similar due to lack of information regarding initial scores and associated meniscal or medial collateral ligament injury.

With regard to study design, there is no explicit explanation of what the aims of the study were or what the outcome measures were. It is not indicated whether these are consecutive cases or whether there were injury criteria to be fulfilled prior to the group recommending surgery. Are the 33 who were followed up in the non-operative group a self-selecting group with poor outcomes continuing to present for follow up?

There is no explicit discussion of when 'initial review or 'follow up' took place. The 2 groups undertook their treatment in different decades, and this could generate additional variation between treatment regimens and clinical evaluation. This is especially important since clinical evaluation was used as an outcome measure, and there is no mention of who undertook this assessment. The outcomes are difficult to follow due to lack of tabulation of results, and upon tabulating it becomes clear that there is a lack of consistent information between the 2 groups. I wonder whether the study would have been easier to follow as a retrospective case series of those undergoing surgery only without including those patients who underwent non-operative management in the previous decade. The lack of uniformity between the 2 groups makes the comparison difficult to make.

Recommendations for our Practice

This study can be taken as a retrospective case series of 47 acute ACL reconstructions in children and adolescents who had predominantly good short-term results. It is difficult to define the cohort of patients who benefitted most from the intervention due to lack of information, but emphasises that it ACL reconstruction with hamstring graft and anchors placed away from physes can be an safe

option that does not cause epiphyseal damage, and should be considered to give best functional outcome.

2. **Kocher MS, Garg S, Micheli LJ.** Physeal sparing Reconstruction of the Anterior Cruciate Ligament in Skeletally Immature Prepubescent Children and Adolescents. *J Bone Joint Surg [Am]* 2005; 87-A: 2371-9.

Reviewer: Mr T Crompton

Background

Management of anterior cruciate injuries in skeletally immature patients is controversial. Conventional surgical reconstruction techniques theoretically risks potential iatrogenic growth disturbance from physeal damage.

Aims

The aim of this paper was to evaluate the results of physeal sparing, combined intra-articular and extra-articular anterior cruciate reconstruction technique in pre-pubescent skeletally immature children. The hypothesis was that the technique described would yield a good functional outcome with minimal risk of a growth disturbance.

Methods

This is a retrospective case series: level 4 evidence. Between 1980 and 2002 fifty patients underwent the described anterior cruciate reconstruction by the two surgeon authors. 44 patients were included in the study (28 boys and 16 girls). 6 patients were lost to follow up. Mean age at operation was 10.3 (3.6-14). Skeletal age and biological age were recorded for comparison with other studies. Patients underwent surgery if they had an associated meniscus injury or they had failed non operative rehabilitation.

Functional outcome was assessed with patient completed questionnaires. The international knee documentation committee (IKDC) subjective knee score and the Lysholm knee score. Objective examination of the knee with Lachman and pivot-shift testing was carried out by 2 of the authors. Radiographic outcome assessment included multiple views to assess integrity of physis and symmetry of Harris lines. Greater than 5 degrees varus or valgus deformity was considered important. Leg length was clinically assessed with greater than 2cm difference considered important. The surgical technique consists of arthroscopically assisted, physeal sparing, combined intra and extra articular reconstruction with autogenous iliotibial band graft. The procedure involves harvesting the iliotibial band leaving it attached distally. The proximal end is tubularised. Arthroscopy of the knee is then performed through standard portals and associated injuries managed. A small notchplasty is performed. The free end of graft is brought through the over the top position and out the anteromedial portal. A second incision over the pes anserinus is made and a curved clamp is passed into the joint under the intermeniscal ligament. The free graft end is then brought through the joint, under the inter meniscal ligament and out through the medial incision. The graft is then sutured on the femoral and tibial sides.

Results

The patients were followed up for a mean of 5.3 years (2.0 - 15.1). No surgical complications were recorded. There were 2 graft failures during sport 4 and 8 years post operatively. Of the remaining 42 patients without revision mean IKDC score was 96.7 +/- 6 and the mean Lysholm knee score was 95.7 +/- 6.7. All patients except three with congenital limb deformity returned to pivoting sports. No patients had significant angular deformity radiographically as assessed by a paediatric radiologist or clinical leg length discrepancy clinically as assessed by the authors.

According to IKDC criteria examination results:

	Normal	Nearly normal	Abnormal
Lachman test	23	18	1
Pivot shift	31	11	0

Paper's Conclusions

There is controversy regarding the management of anterior cruciate injuries in patients with open physes. Non operative management consisting of physiotherapy, bracing and activity restriction can be chosen to delay conventional treatment until near to skeletal maturity or as definitive treatment. This paper quotes several authors who have shown poor clinical outcomes with recurrent instability leading to further chondral and meniscal injury in their patients treated in this way. Similarly when comparing the results of operative and non-operative management this paper again quotes several authors who believe operative patients do better; with less instability, higher levels of activity and return to sports and lower rates of subsequent re injury and meniscal tears.

The paper goes on to discuss the potential for iatrogenic growth disturbance due to physeal damage caused by conventional, transphyseal methods of ACL reconstruction. Animal models have given mixed results with nothing conclusive. Clinical reports of growth disturbance are rare and usually involve fixation across the physis. Other techniques are very briefly discussed for repair avoiding 1 or both physes.

The authors suggest that the prepubescent age group is most susceptible to the potential growth disturbances given the large amount of growth remaining.

They conclude that their technique gives excellent functional results with a low revision rate and no growth disturbance. They recognise it is a non-anatomical reconstruction but state it provides a stable knee and all children in the study returned to sports.

Appraisal

The optimal management of torn anterior cruciate management of the knee is unknown. The patients in this study had good clinical outcomes as assessed on validated knee scoring systems but no conclusions can be drawn from this as to as there was no controls and the objective clinical outcomes were assessed by the authors. No detail regarding rehabilitation programme, duration or compliance was recorded.

This paper has shown that in one centre in the hands of 2 experienced surgeons the particular reconstructive technique described caused no documented harm to the patients

An interesting description of a surgical technique.

Recommendations for our Practice

This paper will not change my practice.

3. **Kumar S, Ahearne D, Hunt D.** Transphyseal ACL reconstruction in the skeletally immature follow up to a minimum of sixteen years of age. *J Bone Joint Surg [Am]* 2013;95-A:e1-6.

Reviewer: Mr A Latif

Background

Early surgical treatment of anterior cruciate ligament (ACL) injuries in children is increasing. There are several methods described, extra-articular techniques or modified, physis-sparing intra-articular techniques. The controversy regarding the safety of such a procedure in children with open physis remains unknown.

Aims

The study reports prospective long-term functional outcomes and complications of a transphyseal ACL reconstruction technique in young children, with a minimum follow up of 4 years post operatively.

Methods

A prospective collection of outcomes data was undertaken on children under 14 years (Tanner score 1 or 2) and under 12 years (Tanner score 3), having ACL reconstruction. 32 children (28 male:4 female) had a minimum of 4 years follow up were included in the study. A clinical examination and a MRI scan confirming ACL tear was performed prior to surgery. The senior surgeon performed all operations using a Hamstring graft. Follow up at 6 months, 1 year and annually thereafter was undertaken. Lysholm and Tegner activity scores were collected. Statistical analysis using Wilcoxin test was performed with a p value set at <0.05. Study is of Level 4 evidence.

Results

Twelve patients had meniscal tears, three had repair at the time of surgery, 3 had a delayed repair and six had a partial menisectomy. The mean Lysholm score improved significantly ($p<0.0001$) from 71.5 preoperatively to 95.86 postoperatively. The mean Tegner activity scale significantly improved from 4.03 preoperatively to 7.66 postoperatively ($p<0.0001$). One graft failed at 9 months post op. One patient developed a valgus deformity at 12 months and one complication of a stitch abscess was observed.

Paper's Conclusions

Several techniques have been described for ACL reconstruction in children; extra-articular and epihyseal techniques. There is concern regarding potential damage to the growth plate during these procedures. Long term outcomes are not known. The transphyseal technique described has shown good long term functional outcomes in children undergoing ACL reconstruction with a minimum follow up of 4 years. In order to minimize potential growth plate damage, drilling should be carried out slowly and centrally. Increased graft tension should be minimized in order to avoid tethering of the epiphysis. The femoral tunnel should be drilled through the tibia in order to achieve vertical drilling, avoiding oblique drilling through the physis and therefore minimizing the cross sectional area of growth plate drilled.

Appraisal

This is a prospective study of a case series with validated outcome scores and good long term follow up. The limitations include a small size with no statistical power performed. There is no control group to compare results with. No analysis of children with meniscal injuries that underwent repair or menisectomy was presented. This is a level 4 evidence study.

Recommendations for our Practice

ACL reconstruction in children remains controversial in terms of age at which the procedure is performed and the technique used. No randomised trails comparing functional outcomes between operative vs non operative management or those comparing the type of surgical technique used has been undertaken. This procedure should be carried out by a specialist Paediatric Knee surgeon with experience in the surgical management of ACL reconstruction in children.

4. **Hui C, Roe J, Ferguson D, Waller A, Salmon L, Pinczewski L.** Outcome of Anatomic Transphyseal Anterior Cruciate Ligament Reconstruction in Tanner Stage 1 and 2 Patients with Open Physes. *Am J Sports Med* 2012; 40:1093

Reviewer: Miss Z Beech

Background

This paper considers the problem of ACL reconstruction in paediatric patients with open physes. Children are generally less able to comply with activity restrictions than adults. A child with an unstable knee is likely to develop osteoarthritis several decades before they would otherwise have been expected to do so and the problem of a severely arthritic knee in a twenty-year-old is one that does not have a good solution. A concern in children is that damage to the growth plate, due to anatomic methods of reconstruction may cause growth arrest, overgrowth or angular deformity. However in adults extra-anatomic methods of ACL reconstruction have been found to have results that are not as good as anatomical reconstruction.

Aims

This paper aims to examine the outcome of an all-arthroscopic, trans-physeal, anatomic, single-bundle, ACL reconstruction with a soft tissue graft in skeletally immature, Tanner grade 1 and 2, patients at a minimum of 2 years after surgery.

Methods

This is a retrospective case-series study of a small number, 16, patients. The operative technique is clearly recorded. Pre-operative assessment included clinical examination, including recording Tanner stage, and plain radiographs. Post operatively patients were again clinically assessed at 6 weeks, 1 year and 2 years post-operatively: recording ligament stability and the presence or absence of limb length discrepancy. The KT-100 arthrometer was also used. The IKDC (International Knee Documentation Committee) form was used. Patients underwent the single-legged hop test for functional assessment. At 2 years standing alignment radiographs were performed to assess limb-length alignment.

Results

All patients had returned to strenuous activities by the time of the 2 year review. No adverse events are recorded; there were no clinically significant leg length discrepancies or angulation. All patients reported a stable knee. 11 had a negative Lachman test with the remainder having a grade 1 result. 2 patients had a pivot glide. On KT-1000 testing 10 were stable, 5 had intermediate findings and 1 had >5mm discrepancy. 13 patients were able to hop >90% of the distance of the other leg. 15 had a normal or near-normal IKDC score.

Paper's Conclusions

The discussion includes a review of the literature although precise search methods are not stated. They include a review of all previous reported growth disturbances. They acknowledge a range of weaknesses in the study. Their final conclusions are that this is a safe procedure in young patients with intra-substance ACL injuries. They claim excellent clinical results with high levels of return to chosen activities. They do not report any growth disturbances.

Appraisal

This paper gives a clear outline of the method used for the operation including the precautions taken to avoid physeal injury. They achieve 100% follow up at 2 years although they do not give the number of children undergoing surgery for ACL injury but excluded from this study. The main weakness of this paper is the small number of cases included. This is an uncommon injury but 16 cases are too few to robustly rule out complications. The use of heterogeneous fixation methods weakens it further; this is acknowledged by the authors. I would question whether 1 case in 16 with >5mm difference on KT-1000 testing – normally held to indicate a rupture, is necessarily a good outcome.

Recommendations for our Practice

ACL-ruptures in pre-pubertal children may be treated with anatomical trans-physeal CL reconstruction but consideration should be given to performing this surgery in specialist centres and careful follow-up is essential.