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ORIGINAL ARTICLE • KNEE - SPORT

Revision ACL reconstruction with autograft: long-term functional outcomes and influencing factors

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Abstract

Purpose To present the long-term functional outcomes of revision anterior cruciate ligament (ACL) reconstruction with autograft and factors that influence the outcomes.

Methods Retrospective study of 51 consecutive revision ACL reconstructions performed using autograft under the care of a single surgeon with interference screw fixation. Bone-patellar tendon-bone graft was used in 35 (69%) and hamstring tendons in 16 (31%). The subjective IKDC activity level and Lysholm Knee functional scores were collected at mean follow-up of 9.0 years (range 5.17–14.75 years).

Results Five (9.8%) had re-ruptured and one patient had a total knee replacement. Functional scores were available for 43 patients (84.3%). Twenty-eight had IKDC activity level I or II (65%), level III in 12 (28%) and level IV in 3 (7%). The average Lysholm score was 86.2 ± 12.88, and there is a statistically significant relationship with age (95% CI: -0.88, -0.60) ($P < 0.05$). For each additional 10 years of age, there is a reduction of 5.18 points. No statistically significant effect of sex has been detected. The mean Lysholm score was lower in patients who had partial medial meniscectomy (77.33), although this was not statistically significant ($P = 0.06$). Regression analysis of the Lysholm score means by chondral damage category adjusted for age, showed that the Grade 3 or 4 group shows a reduction of about 25 points for every 10 years increase in age (95% CI; $P = 0.05$).

Conclusion Revision ACL reconstruction with autograft affords satisfactory long-term outcomes. Expectations should be carefully managed in patients with increasing age associated with severe chondral damage and previous medial meniscectomy.

Keywords Anterior cruciate ligament · Revision surgery · Functional outcomes

Introduction

Rupture of the anterior cruciate ligament (ACL) in the knee is one of the most common knee injuries, with an incidence of approximately 30 ACL injuries per 100,000 people in the UK each year, with an estimated one million ACL injuries worldwide [1].

Improvements in operative technique and rehabilitation planning have led to significantly reduced morbidity after ACL injury; however, the increasing numbers of ACL reconstruction operations have led to an increase in the need for revision surgery. There can be a number of different reasons for needing a revision reconstruction: graft failure due to technical error, biologic failure, failure due to trauma, or failure due to unrecognised secondary rotary instability, skeletal malalignment or varus/valgus instability [2]. The number of revision procedures carried out will also continue to rise, as the population's expectations of being more active later in life rises simultaneously.

Data from national registries have shown that approximately 10% of all ACL reconstruction operations are revision procedures [2], so there has been limited opportunity to perform large-scale studies around revision surgery. However, the establishment of the aforementioned national registries in both Scandinavia [2] and the US (the MOON cohort [3]) have gone some way to addressing this issue. Both have shown that revision ACL surgery is less common and less predictable than primary reconstruction [2, 3].

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One of the main issues facing the surgeon before a revision operation is the choice of graft: these include autografts, allografts and synthetic grafts. In our unit, semitendinosus gracilis (STG) hamstring or bone-patellar tendon-bone (BPTB) autografts are the standard choice for primary reconstruction. This can be problematic for subsequent revision surgery due to lack of availability of graft. There is a paucity of long-term studies on the use of autografts in revision operations, which we aim to address in this paper.

While there have been several studies [4, 5] looking at outcomes in the medium-term after revision surgery, and which showed significantly worse outcomes using patient-based measures compared to the original reconstruction, studies assessing long-term outcomes have been less common. This is important when considering the fact that the main cohort of patients who undergo ACL revision operations are young, physically active and hence may rely on a revision operation to sustain knee function at an acceptable level for several decades.

The aim of this study was to assess the subjective long-term knee function and activity level following revision anterior cruciate ligament reconstruction with autograft, performed under a single surgeon utilising autologous graft and interference fixation, and to evaluate the patient related factors affecting the outcome.

Methods

All the patients included in this study underwent revision ACL reconstruction under the care of a single, experienced knee surgeon (RN). The study period was from the 1 January 2001 until the 31 December 2010. Fifty-one patients met the inclusion criteria for the study: arthroscopic revision ACL reconstruction with either STG or BPTB autograft, with a minimum time period of 6 years having passed since the revision surgery.

All patients included in the study had undergone the same surgical technique; either a STG 4-strand hamstring (if used previously and technical failure) or BPTB autograft (if non-technical failure), with anteromedial portal femoral drilling, outside in tibial tunnel and aperture fixation with a Round Cannulated Interface Screw System (RCI; Smith & Nephew, CA).

Retrospective review of all the clinical and operative notes was undertaken, and any patients meeting the inclusion criteria were contacted, firstly in the form of a letter, with an included questionnaire, the Tegner–Lysholm knee score [6], and then a phone-call following, this had there been no reply to the paper questionnaire. Patients were also asked to complete the IKDC functional activity level form [7]. The study was undertaken as part of a routine service evaluation; hence, ethical approval was not required.

Results from the questionnaires were tabulated using Microsoft Excel 2010, along with all the operative details from the revision surgery. Statistical analysis of the data was then performed on SPSS 22, including R and regression analysis with bootstrapping.

Results

Fifty-one patients met the inclusion criteria for the study. The mean age was 26.5 (17–44) years. Forty-four (86.3%) were male and 7 (13.7%) were female. Twenty-three (45.1%) had right-sided reconstruction and 28 (54.9%) had left-sided reconstruction.

The mean follow-up time for the patients in the study was 9.0 (6.5–16.1) years. Tegner–Lysholm scores and IKDC functional activity scores were obtained for 42 patients (82.3%).

Traumatic re-injury was the most common mechanism of failure occurring in 32 (63%) knees, technical failure was the cause in 13 (25%), biologic/slack graft failure was the cause in 5 (10%), and infection was the cause in 1 (2%). Thirty-seven of the primary operations were performed by the senior surgeon (RN), while the remaining 14 primary operations were performed by other surgeons. Traumatic re-injury was the most common mechanism in both the primary operations performed by RN, and the operations were performed by the other surgeons.

In terms of the revision reconstruction, all 51 patients had interference fixation. Forty-eight (94%) patients had one-stage revision surgery, and the remaining three (6%) patients had two-stage surgery. Three-five (69%) patients had a BPTB graft, all from the ipsilateral leg, while 16 (31%) patients had STG graft (from ipsilateral leg in 10, contralateral leg in 6). The Outerbridge Classification [8] was used to grade the articular surface of the affected knee (Fig. 1). Meniscal pathology was recorded; 18 (35%) knees had normal menisci, 28 (55%) required partial meniscectomy (lateral meniscus in 11, medial meniscus in 7 and both in 10), and five (10%) patients required meniscal repair (10%).

The Tegner–Lysholm score is a valid and reliable scoring tool [9] and was used to assess long-term functional outcomes. Twenty-one (50%) patients who responded had a score of 90 or above, which corresponds with an 'Excellent' outcome. Six (14%) patients scored between 84 and 90, a 'Good' outcome, 13 (31%) patients scored between 65 and 83, a 'Fair' outcome, and two (5%) patients scored less than 65, a 'Poor' outcome. The mean score was 86.1 ($\pm$ 12.9).

No statistically significant difference was detected with regards to Tegner–Lysholm score and gender of the patient. Regression analysis with fitting parallel lines shows a statistically significant relationship ($P = 0.009$) with age, within chondral damage categories (Fig. 2). There was a common

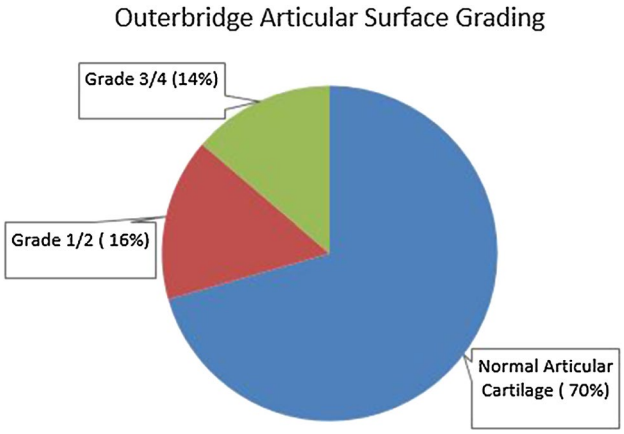

Fig. 1 Articular damage noted during revision surgery

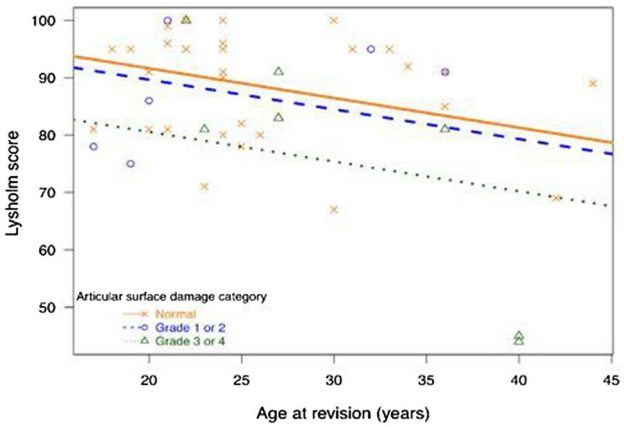

Fig. 2 Regression analysis comparing the Lysholm score with age

slope of −0.518 (95% CI; −1.037, −0.059), indicating that for each additional 10 years of age there was a reduction of 5.18 points on the Lysholm score. Within the chondral damage categories themselves, there are further differences; further regression analysis of the relationship between age and Lysholm score within the Grade 3 and Grade 4 categories again shows a significant difference ($P=0.05$); the slope for the Grade 3–4 graph is −2.508 (95% CI −4.831 to −1.804), suggesting a reduction of about 25 Lysholm score points for every 10 year increase in age (Fig. 3). The Lysholm score was lowest in patients who also had a partial medial meniscectomy, in addition to the ACL reconstruction. However, this was not statistically significant ($P=0.06$, Table 1).

Patients were also asked to fill out an IKDC subjective knee evaluation score. Twenty-one out of 42 patients (50%) had an IKDC score of Level 1 (Strenuous), the highest level possible. Eight patients (19%) scored at level 2 (moderate), 10 patients (24%) at level 3 (light recreational) and three patients (7%) at level 4 (sedentary), the lowest level.

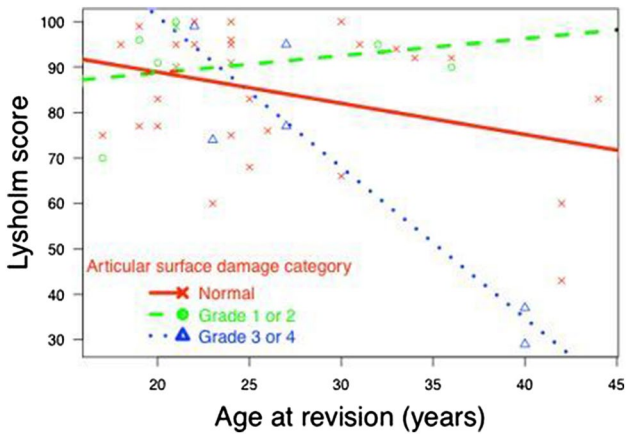

Fig. 3 Further regression analysis, comparing the Lysholm score with chondral damage category, adjusted for age

There was failure of revision surgery in 6 of the 51 patients (11.7%). Four patients had graft rupture secondary to re-injury (with 3 of those having a 2nd revision operation, and 1 managed conservatively), one patient had persistent instability (managed conservatively), and one patient suffered from progressive osteoarthritis in the affected knee, for which they subsequently had a total knee replacement. There were no post-operative infections reported.

Ten patients (17.6%) required further surgery. Four patients had meniscectomies, one patient had a total knee replacement, one patient had a re-revision ACL surgery, one had a tibial screw removed, one had a cyclops excision after a repeat arthroscopy, and one had an arthroscopy, during which microfracture was performed (Table 2).

Discussion

The annual incidence of revision ACL reconstruction continues to rise [10]. Patients who undergo both primary and revision ACL reconstruction tend to be young and active, with high functional demands. Therefore, it is vital to understand factors that are likely to adversely affect outcomes, to provide care that will best suit their individual needs. Although revision surgery is associated with inferior outcomes to primary ACL reconstruction [11, 12], our study demonstrates that the large majority of patients achieve a good to excellent long-term functional result following revision ACL reconstruction, using an autograft technique. The mean Tegner–Lysholm score of 86.1 is consistent with the early results reported in the literature. Jiang et al. [13] achieved a mean post-operative Lysholm score of 87.7 at 2 years, using a double bundle technique in 34 patients. In two meta-analyses of revision ACL reconstructions, scores

Table 1 The relationship between Lysholm score and requirement for meniscectomy

Variable	Meniscal surgery				*P* value
	N = normal $n = 17$	L = lateral $n = 11$	M = medial $n = 6$	B = lateral and medial $n = 9$	
	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	
Lysholm score	83.95 (2.65)	91.80 (3.31)	77.33 (4.45)	89.34 (3.63)	0.06

SE bootstrap standard error

Table 2 Patients who had further surgery after the revision ACL operation

Procedure	Number of patients
Arthroscopic meniscectomy	4
Total knee replacement	1
Re-revision ACL	1
Removal of a tibial screw	1
Repeat arthroscopy + cyclops excision	1
Repeat arthroscopy (microfracture)	1

of 82.1 [12] and 87.5 [11] were recorded at 5.4 and 5 years, respectively, using a mixture of techniques.

Our study identifies a statistically significant correlation between increasing age and worse functional outcome in those who have significant (Outerbridge 3 or 4) chondral damage. The significant effects of chondral damage at the time of revision surgery on short to mid-term functional outcomes are well established [14, 15] and correlates with what is known about primary ACL reconstruction from the MOON study group [16]. The MARS study [14] reported 2-year follow-up on 989 patients and demonstrated significantly worse outcomes in patients who had sustained meniscal injury or who had evidence of Outerbridge grade 3 or 4 chondral damage in the trochlea. Webster et al. [15] reported reduced functional scores and a lower rate of return to sport in 180 patients who had ICRS (International Cartilage Repair Society) 3 or 4 chondral pathology at a mean 4.6 years. Anand et al. [17] reported on 136 patients with mean 5-year follow-up. They found significantly higher Marx, KOOS, and IKDC scores for patients with IRCS grade 0, 1 and 2 chondral damage compared to those grade 3 and 4 changes. These same patients were also statistically more likely to return to sporting activity compared to those with a grade 3 or 4 lesions (52 vs. 31%). Our study demonstrates that this finding remains consistent over longer-term follow-up.

Increasing age has been reported as an independent risk factor for an inferior outcome in primary ACL Reconstruction [16]. Its importance in the presence of significant chondral damage following primary ACL reconstruction has also been described. Blyth et al. [18] demonstrated that, although primary ACL reconstruction in patients over 50 years old is a reliable form of intervention, those with Outerbridge grade 3 or 4 changes in articular cartilage had overall lower IKDC scores and outcome. Age is also a risk factor for deterioration in the articular cartilage of both the medial and lateral compartments of the knee between primary and revision surgery [16]. Its role in determining functional outcome following revision ACL reconstruction has not previously been analysed, to our knowledge.

Our data show a non-statistically significant trend towards a worse outcome when a concurrent partial medial meniscectomy was performed. Lateral tears are more common in primary ACL knees, with reports that medial tears are more common in revision knees [19]. In our series, lateral tears (41%) were more common than medial tears (33%). Our findings on functional outcome are in keeping with both a previous meta-analysis [12] which reported significantly lower Marx, KOOS-QOL and SANE scores in patients who had either a preexisting or new medial meniscus tear, and with data showing significantly increased odds ratio of pain, stiffness and symptoms in patients with previous meniscal injury [14]. It has also been reported that there is an increased risk of significant articular cartilage damage in patients who had a partial meniscectomy, compared to those with no history of meniscus surgery at the time of the revision surgery [20]. These findings could be influenced by the development of osteoarthritis, with studies showing that along with patient age at injury and obesity, meniscal injury was one of the strongest risk factors developing grade 3 or 4 changes [21] and thus knee osteoarthritis [22]. Although our study did not find a statistically significant link, it suggests that medial meniscus pathology may continue to play a role in determining functional outcome over a longer period of follow-up than previous studies.

The benefits of using autograft for primary ACL reconstruction are well established [23]. Their suitability for use in revision ACL reconstruction has been demonstrated in a recent meta-analysis. Grassi et al. [24] reviewed 32 studies and found that autograft had fewer complications and lower post-operative laxity as compared to autograft reconstruction.

The failure rate in this study was 11.7% (6 patients), which is comparable to the systematic review by Wright

et al. [12], who reported a re-revision rate of 13.7% at much shorter follow-up of 5.4 years compared to ours at 9.0 years.

We accept that our study has limitations. It is retrospective and utilises a subjective patient reported functional outcome scores, with a satisfactory response rate (82%). There are also no pre-revision scores to compare to. Although two different autografts (BPTB and STG) were used, the surgical technique was same, and performed by a single surgeon. To our knowledge, this is the only series with the longest follow-up (9.0 years) following revision ACL reconstruction with autografts; hence, we feel the findings are relevant in adding to the current base of evidence for treatment in this group of patients.

Conclusions

This study demonstrates that revision ACL reconstruction using autograft provides good to excellent long-term functional outcomes for the majority of patients. Older patients with significant chondral damage should be counselled that these are risk factors for a worse outcome, and this should be taken into account when making the decision to proceed to revision ACL reconstruction.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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