J Orthopaed Traumatol (2004) 5:142–146
DOI 10.1007/s10195-004-0060-7

ORIGINAL

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Revision ACL reconstruction using doubled semitendinosus and gracilis tendons: a follow-up study

Received: 18 August 2003
Accepted: 15 July 2004

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Abstract Few papers report the results of revision ACL reconstruction with hamstrings tendons. We report our results with revision anterior cruciate ligament (ACL) surgery using a doubled gracilis and semitendinosus tendons (DGST) graft, in association with an exta-articular procedure. Twelve patients underwent ACL revision surgery using autogenous homolateral DGST graft in association with an extra-articular procedure and were evaluated at a mean follow-up of 35 months. At follow-up evaluation, all patients scored negatively on the Lachman test and normally or near normally on the jerk test. The KT 1000 evaluation showed a average side-to-side difference at 30 lb and MM of 1.4±1.7 mm and 1.6±1.6 mm, respectively. The Lysholm score was 98±2 (range, 94–100); excellent results (score 95–100) were obtained in 83% of cases, good results (score 84–94) in 17%, and no fair or poor results. At the IKDC evaluation, the result was excellent (normal) in one-thirds of cases and good (nearly normal) in two-thirds. Therefore, the use of hamstring tendons in association with lateral tenodesis seems to be a good alternative to the use of allografts or contralateral bone-patellar tendon-bone graft in revision ACL reconstructions.

Key words ACL reconstruction • Semitendinosus tendon • Gracilis tendon • ACL revision surgery

Introduction

A torn anterior cruciate ligament (ACL) can be responsible for knee disability in two major ways. First, ACL deficiency may cause symptomatic instability in several activities ranging from jumping, pivoting and cutting sports to activities of daily living. Moreover, repeated episodes of instability and the subsequent damage to the articular cartilage and menisci predispose the patient to degenerative joint changes [1, 2]. Therefore, the number of ACL reconstructive procedures has increased and the intra-articular substitution of the ACL is now considered the treatment of choice for functional instability following a torn ACL. The rate of success in ACL reconstruction ranges from 75% to 95% of treated cases [3, 4], with a return to the desired daily or sport activities and restoration of the knee stability.

Although techniques and options for suitable graft substitutes for ACL reconstruction continue to improve, failures of these reconstructions can occur due to many reasons, including: preoperative status of the knee in terms of ligament injuries and associated pathologies such as the state of menisci and articular cartilage; intra-operatively, inadequate notchplasty, improper tunnel placement, improper tensioning, inadequate fixation and faulty selection or harvest of the graft; postoperatively, failures resulting from improper graft incorporation, improper rehabilitation or subsequent trauma [5, 6]. The incidence of failure is difficult to determine, because there is a lack of uniformity in the definition of a failure. When failure is defined as recurrent pathological

laxity (side-to-side difference >5 mm in KT-1000 or pivot shift test grade 2 or 3), the incidence in long-term series is highly variable and ranges from 3% to 22% [7]. While the literature about primary ACL reconstruction is substantial, few papers deal with revision ACL surgery. Some authors have reported the results of revision of failed ACL reconstruction using contralateral bone-patellar tendon-bone (BPTB) allografts or prosthetic ligaments [7–11], but, to our knowledge, no one has described the outcomes of revision surgery using hamstring tendons. The purpose of this paper is to report our results of revision ACL surgery using a doubled gracilis and semitendinosus tendons (DGST) graft, in association with an extra-articular procedure.

Materials and methods

Between 1996 and 1999, a total of 14 revision ACL reconstructions with DGST graft were done by the same senior author (A. Ferretti). Two patients had not returned for follow-up examination, therefore 12 patients were evaluated. The primary ACL reconstruction was done in other hospitals using BPTB in 8 cases and prosthetic ligament in 4 cases. In association with the first reconstruction, 3 medial and 2 lateral partial meniscectomies, 1 medial meniscal repair and 1 lateral meniscal repair were also perfermed. Seven patients attributed the symptoms to a new knee injury that had occurred during sport activity. The average time from the primary reconstruction to revision was 5 years (range, 1–11 years)

A preoperative evaluation consisted in a physical examination and scoring on the Lysholm functional knee score [12], the Lachman test [13] and the jerk test [14]. We also carried out a standard radiographic examination to evaluate for degenerative changes, the orientation and possible enlargement of the tunnels, and the presence of fixation devices.

The surgical technique for reconstruction was an arthroscopically assisted two-incision technique using autogenous homolateral doubled semitendinosus and gracilis tendon graft. The graft was fixed on the femur with the Swing-Bridge (Citieffe, Bologna, Italy) and on the tibia with 2 staples in a belt-buckle fashion. The Swing-Bridge is a DGST femoral fixation device that can be used in double-incision ACL surgery, and it offers strong and stiff fixation by means of it's cortical grip [15, 16]. In 4 cases, two-stage revision was done due to the problematic removal of pre-existing fixation device or bone tunnel enlargement. In addition to the ACL revision surgery, 4 partial lateral meniscectomies and 2 partial medial meniscetomies were also performed. In all cases, an extra-articular procedure (Coker-Arnold modified by McIntosh and Darby [17]) was also performed: this involved an ileotibial band reflection, passing under the lateral ligament, without bone tunnel, and suturing with periosteal stitches on Gerdy's tubercle.

The follow-up examination included subjective evaluation of pain, joint instability, and satisfaction of patient scored on a scale from 1 to 10 in which 1 meant no satisfaction and 10 the highest satisfaction. The objective evaluation considered range of motion (ROM), Lachman test, jerk test, Lysholm test, evaluation according to the guidelines of the International Knee Documentation Center (IKDC) [18], and type and level of return to sport activities. Anterior laxity was quantified with the KT-1000 arthrometer 30 lb and Maximum Manual (MM) [19] drawer test (side-to-side difference).

Results

A total of 12 patients (10 men) of mean age 28 years (range, 24–37 years) underwent revision reconstructive surgery of the anterior cruciate ligament (ACL). Preoperatively, all patients had recurrent pathological knee laxity and pain, but range of motion (ROM) was not limited. They all scored

Table 1 Clinical characteristics of 12 patients who underwent revision reconstruction surgery of the anterior cruciate ligament (ACL), properatively and at a mean follow-up of 35 months (range, 24–50 months). Values are number (percentage) of patients unless otherwise indicated

	Preoperative evaluation		Follow-up evaluation	
Lachman test				
Negative	0	(0)	12	(100)
Positive	12	(100)	0	(0)
Jerk test				
Normal (-)	0	(0)	10	(83)
Nearly normal (+)	3	(25)	2	(17)
Abnormal (++)	4	(33)	0	(0)
Severely abnormal (+++)	5	(42)	0	(0)
Lysholm functional knee scale				
Excellent (95–100)	0	(12)	10	(83)
Good (84–94)	0	(12)	2	(17)
Fair (x–83)	8	(12)	0	(0)
Poor (x–y)	4	(12)	0	(0)
Aggregated score[a]	x (y; x–y)		98 (2; 94–100)	

[a] Values are mean (SD, range)

Table 2 KT-1000 arthrometric measurement of knee stability after ACL revision in 12 patients

KT-1000 test	Patients, n (%)
30 lb side-to-side difference	
<3 mm	10 (83)
3–5 mm	2 (17)
>5 mm	0 (0)
MM drawer side-to-side difference	
<3 mm	9 (75)
3–5 mm	3 (25)
>5 mm	0 (0)

MM, Maximum Manual test

positively on the Lachman test, and 9 of 12 patients had abnormal results on the jerk test (Table 1).

The preoperative radiographic evaluation showed no enlargement of femoral and tibial tunnels. Only in 4 cases did we observe mild degenerative changes, such as flattening, squaring, ridging of femoral condyles (Fairbank signs) [20]. There was improper placement of the tibial or femoral tunnel in 4 cases. Second- or third-degree chondromalacia was observed in 3 patients.

The follow-up evaluation was performed at a mean of 35 months (range, 24–50 months). All patients scored negatively on the Lachman test and had a normal or nearly normal score on the jerk test (Table 1). The aggregated Lysholm score was 98±2 (range, 94–100).

The KT-1000 evaluation (Table 2) showed an average side-to-side difference at 30 lb and and MM score of 1.4±1.7 mm and 1.6±1.6 mm, respectively. At the IKDC evaluation, the result was excellent (normal) in 10 cases (83%) and good (nearly normal) in 2 cases (17%). No patient referred knee instability and 9 referred no pain. All patients had full active and passive ROM. Postoperative satisfaction, evaluated on a scale of 1 to 10, gave a mean score of 8.7 (range, 7–10).

Four patients returned to the same level of the desired activity (professional volleyball, football and basketball); two patients begun a much less dangerous sport activity after surgery (body building); in other cases, the patients returned to the same activity but at a lower level.

Discussion

The number of patients with failed anterior cruciate ligament reconstruction has risen during the last 10–15 years, because of the considerable increase of primary reconstructions [7–11]. Not all patients with a failed ACL reconstruction are candidates for revision surgery. Patients with recurrent symptoms of instability in sports activities or in daily living and with laxity determined objectively (e.g. Lachman and jerk tests) are candidates for revision surgery; patients with pain and swelling alone, without pathological laxity, could present meniscal tears or cartilage degeneration and probably are not suited for ACL revision surgery. In our study, all patients had knee pain and instability in sports and daily activities and an objective evaluation revealed in all cases a positive score on the Lachman test and in 75% of cases an abnormal jerk test score.

The most common etiologic factor of ACL failure is an error in surgical technique: a improper intra-articular placement of the graft; impingement of the graft in the intercondylar notch due to an insufficent notchplasty or to an anteriorly placed tibial tunnel; a improper tension of the graft or inadeguate graft fixation. Other causes of ACL failure are infections, a new knee injury or recurrent swelling following the use of prosthetic ligament in the primary reconstruction [6].

Surgical revision of a failed ACL reconstruction requires thorough preoperative planning and evaluation of the factors that may have caused the failure so that the correction of these problems may be addressed during the revision operation. This should include a thorough history, a physical examination and a standard radiographic examination to evaluate the degenerative changes, the orientation of the tunnels and their possible enlargement, and the type of preexisting fixation devices. In our study, causes of the failure were well documented errors in surgical technique in the primary reconstruction in 4 cases (improper placement of bone tunnels), secondary knee injuries in sport activities in 4 cases and rupture of a prosthetic ligament in 4 cases. Other factors should be evaluated before planning a revision: the surgical technique and the graft used in the primary reconstruction; the removal of fixation devices or prosthetic ligament; the choice of the graft for revision surgery; and the possibility of a two-stage procedure.

The most common causes of two-stage procedure are the bone tunnel enlargement, often due to the use of prosthetic ligament [9], the problems encountered in removal of the devices, and the osteolysis around tunnels that may require bone grafting of the tunnels. In our study, we had 4 two-stage procedures due to previously, incorrectly placed bone tunnels or to a problematic removal of the fixation devices which requires a further enlargement of the tunnels. There were 3 cases of failed prosthetic ligaments and 1 of failed BPTB graft.

Several options exist for revision graft selection: ipsilateral or contralateral BPTB; allograft patellar tendon; quadriceps tendon; and hamstring tendons. The use of

prosthetic ligaments is generally contraindicated because of the high complication rates, in both primary or revision surgery [21–23]. The more commonly used grafts are the contralateral BPTB graft, the fresh-frozen BPTB allograft in case of failed autogenous BPTB [7, 8, 10, 11] and autogenous homolateral BPTB in failed prosthetic ligament [9]. The use of allograft tissue for revision ACL reconstuction surgery recently has been criticized: the cost of the tissue, the efficacy of the procedure in patients with chronic laxity and disease transmission should be considered [7]. The use of contralateral BPTB graft implies harvesting the graft from the contralateral leg, and often the patients are resistant to this idea [11].

Our first choice is to use hamstring tendons in all cases, where this graft was not used in primary ACL reconstruction. We also used hamstrings since 1979 for primary reconstruction with satisfactory results with well known advantages: no donor site morbidity, early return of normal ROM and no interference with the extensor mechanism [24, 25]. The use of a Swing-Bridge femoral fixation device [15, 16] with excellent biomechanical properties such as strength and stiffness can make the use of hamstrings even more reliable also in revision surgery. Moreover, the two-incision technique seems to be a good choice especially in cases in which a half-tunnel technique was used in primary reconstruction. In fact, the new graft can be fixed in a previously undrilled area of the lateral femoral condyle.

The role and effectiveness of a lateral extra-articular procedure in association with ACL reconstruction is controversial. While some authors believe that postoperative stability cannot be improved by any additional procedure [26], others reported better results in cases where an extra-articular iliotibial band tenodesis was associated with an intra-articular ACL reconstruction, especially if a semitendinous and gracilis (STG) graft was used [27]. In primary ACL reconstruction, we perform modified McIntosh lateral tenodesis in association with intra-articular DGST reconstruction only in severe rotatory instabilities (jerk test score, severely abnormal). However, in revision ACL surgery, we believe that this procedure, which could protect the graft from excessive, undesired stresses during the first postoperative period contributing to a better postoperative stability, should be recommended in all cases.

Although revision ACL surgery is often expected not to yield the same results as a primary reconstruction and may be considered to be a salvage procedure [8] with limited goals such as stability to allow work, activities of daily living and light recreational sport, the results of this experience compared well with those reported in literature concerning both primary and revision ACL surgery. At the objective follow-up evaluation, all patients scored negatively on the Lachman test and normally or nearly normally on the jerk test. The KT-1000 evaluation showed a average side-to-side difference at 30 lb and MM score of 1.4±1.7 mm and 1.6±1.6 mm, respectively. The Lysholm score was 98±2 (range, 94–100): excellent results (score 95–100) were observed in 83%, good results (score 84–94) in 17%, and no fair or poor results. At the IKDC evaluation, the result was excellent (normal) in 83% of cases and good (nearly normal) in 17%.

The return to the sporting activities at the same level before the first injury, which often represents the patient's main goal, was obtained in 33% of patients; 17% of patients preferred a less dangerous activity, not due to the operated knee but to other factors (work, family responsibilities or fear of a new injury) and 50% of patients returned the same recreational activity but at a lower level after the revision surgery. However, no patients referred incapacity in performing jumping or cutting activities due to knee instability. Therefore, the emotional status of patients and their motivations to rehabilitation are other issues to be considered for a successful revision surgery, and should be included in the preoperative planning.

Several studies demonstrated the correlation between cartilage damage and the clinical outcomes of ACL primary and revision surgeries [7, 10]. Therefore, in patients with significant articular cartilage damage, the goal of the operation is often to decrease symptoms with activities of daily living and possibily allow a return to light recreational activity. Our series represents a selective group of patients, since abnormal articular cartilage surfaces were found only in 3 cases; therefore, we cannot confirm this finding. Moreover, this fact might explain the high number of satisfactory results presented here.

We also should consider that the follow-up is too short to evaluate radiographic changes occurring postoperatively after a revision surgery. Degenerative arthritis development, which is considered a main issue after revision surgery, can be studied only in longer term follow-up studies

In conclusion, this study suggests that the use of hamstring tendons in association with lateral tenodesis is a good alternative to the use of allografts or contralateral BPTB graft in revision ACL reconstructions. While other authors considered the ACL revision surgery as a salvage procedure, the present study also suggests that early functional results can be similar to those of primary reconstruction if the revision is performed before severe degenerative joint changes occur.

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