ORIGINAL PAPER

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Comparative study of autograft or allograft in primary anterior cruciate ligament reconstruction

Abstract Between December 1996 and December 2002, we treated 79 patients with arthroscopy-assisted anterior cruciate ligament (ACL) reconstructions. In 53 patients we used autografts and in 26 patients allografts. Patients were followed up for 38 (12–72) months. The two groups did not differ in preoperative sport activity level. The postoperative Lysholm score was 89.9±8.1 in the autograft group and 84.1±18.6 in the allograft group. Comparing the patients' Lysholm score according to whether they had a low (1–5) or a high (6–10) postoperative Tegner score, we found no statistically significant difference between the groups. On one occasion, the allograft ruptured during the implantation procedure just prior to the fixation. Postoperatively, we performed three revisions—two in the allograft group and one in the autograft group—and three second-look arthroscopies. There were no bacterial infections and no cases of viral transmission. No immune rejection, resorption, or immunsynovitis occurred during the follow-up.

Résumé Entre décembre 1996 et décembre 2002 nous avons traité 79 malades par reconstruction du LCA sous arthroscopie. Chez 53 malades nous avons utilisé une autogreffe et, pour 26, une allogreffe. Les malades ont été suivis 38 mois (12–72). Les deux groupes n'étaient pas différents dans le niveau de l'activité sportive préopératoire. Le score Lysholm postopératoire était de 89,9±8,1 dans le groupe autogreffe et de 84,1±18,6 dans le groupe allogreffe. En comparant le score Lysholm des malades selon qu'ils avaient un score postopératoire de Tegner haut (6–10) ou bas (1–5), nous n'avons pas trouvé de différence significative entre les deux groupes. Dans un cas l'allogreffe s'est rompue pendant la procédure d'implanta-tion, juste avant la fixation. Après l'intervention nous avons fait trois révisions, deux dans le groupe allogreffe et un dans le groupe autogreffe, et trois arthroscopies de seconde vision. Il n'y avait pas d'infection bactérienne, aucuns cas de transmission virale. Aucun rejet immunitaire, résorption ou synovite immune ne se sont produits pendant le suivi.

Introduction

Following the first allogeneic reconstructions of the anterior cruciate ligament (ACL) [16, 17], allograft has become an important alternative to the often-used autologous bone-tendon-bone (BTB) grafts. Due to fear of transmitting viral diseases, reconstruction using allografts is often considered unsafe. The method has therefore remained highly restricted, and allografts are mostly used in revisions of failed autogenous ACL reconstructions [10] where ipsilateral or contralateral graft harvesting is unwanted. Recently, virus screening procedures have been improved, and the detection free-window periods are significantly shorter, reducing the risk of disease transmission.

In the last decade, several reports have discussed ACL reconstruction, yet comparison between BTB grafts of different origins (allografts or autografts) are scarcely available in the literature [11, 14, 15, 19]. We report here a comparative study of primary ACL reconstructions using either autogenous or allogeneic BTB grafts.

Materials and methods

We reviewed 79 patients who between December 1996 and December 2002 had an arthroscopy-assisted primary ACL reconstruction for chronic ACL deficiency (i.e., more than 6 weeks after the primary injury). All patients except three injured their knee during sports, with soccer and handball being most frequent. Patients received either autogenous or allogeneic BTB graft. Graft selection was

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not randomized but rather determined according to the patient's preference. Patients were given the option to choose between autograft and allograft after detailed explanation of risk and benefit of both procedures.

Allografts were removed under sterile surgical conditions from donors suitable for other organ donation as well and stored immediately at −80°C as fresh-frozen specimens. In accordance with international regulations, all donors were screened for viral antigens (e.g., HIV, HBV, HCV, etc.). Allografts were not sterilized secondarily (not irradiated) to maintain best biomechanical properties.

Some patients had an arthroscopy prior to the index operation, and meniscal repair and debridement was performed if indicated. In other cases, the additional injuries of the knee were treated at the time of the actual ACL reconstruction. All grafts were implanted using analogous arthroscopic techniques. Patients were followed up for an average of 38 (12–72) months postoperatively. Fifty-three patients (14 women and 38 men) received allografts and 26 patients (four women and 22 men) autografts.

Surgical technique

BTB autograft or freshly thawed allograft—10 to 11 mm in diameter—were prepared immediately before implantation (Fig. 1) and following standard procedure were pulled into place and secured into the femoral and tibial tunnel with interference screws (7–8 mm in diameter and 20–30 mm in length).

All patients were given largely similar rehabilitation including immediate full extension and immobilization in a brace. From the second postoperative day on, continuous passive motion was carried out. Full weight bearing was allowed after 1 week. Return to previous levels of activity was not recommended before the end of the first year postoperatively. Patient's functional results and subjective evaluation was reported and assessed by an independent examiner. For subjective data collection, Lysholm knee scoring scale and Tegner activity score were used [20]. In addition, for the registration of the objective physical status, IKDC (International Knee Documentation Committee) knee ligament standard evaluation forms were completed by the examining physician.

Statistical analysis

Student's *t* test, chi-square test, and analysis of variance (ANOVA) were applied for statistical analysis using SPSS 10 software (SPSS, Chicago, IL, USA). *P* value was set to 0.05 for significance.

Results

All patients were examined. Fifty-three patients (average age 25.6 years) chose an allograft and 26 (average age 24.5 years) an autograft. In the group with allografts, 26 were implanted in the right and 27 in the left knee. In the group with autografts, 16 were implanted in the right and ten in the left knee. The two groups did not differ in their sports activity level (Tegner's activity score).

Postoperative subjective satisfaction was measured using Lysholm knee scoring scale [6]. In the group that received autografts, the average total Lysholm score was 89.9±8.1, while in the group that received allografts, the score was 84.1±18.6 (Table 1). When three patients with extremely low scores (three-σ exclusion rule; Lysholm score lower than 45) were excluded, the allograft group reached similarly high scores (89.5±8.7) as the other group. In neither case, however, were significant differences present between the two groups. Detailed results of the point losses in different categories are shown in Table 2. The postoperative physical and sports activity influences the subjective as well as on the objective results of the assessment. We therefore grouped the patients into two distinct populations with respect to their postoperative Tegner's score. When these groups were compared separately using the Lysholm knee scoring scale, no statistically significant difference was found between the autograft- and allograft-reconstructed individuals suggesting that the two methods are comparably successful (Fig. 2).
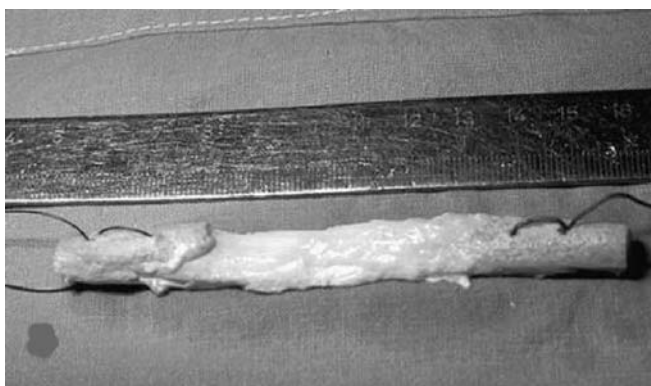

Fig. 1 Macroscopic appearance of the bone-patellar tendon-bone allograft after final preparation

Table 1 Subjective and functional results of anterior cruciate ligament (ACL) reconstruction in autograft- and allograft-transplanted patients

	Autograft *n*=26	Allograft *n*=53
Lysholm score		
90–100	13	30
80–89	10	14
70–79	3	5
<70	0	4
Single-leg-hop test		
≥90%	23	42
≥80%	2	7
≥70%	1	1
<70%	0	3

Table 2 Comparison of subjective results in autograft- and allograft-transplanted patients using Lysholm knee scoring scale. In each category, the average and maximum score is shown. The average loss of points is shown in parenthesis

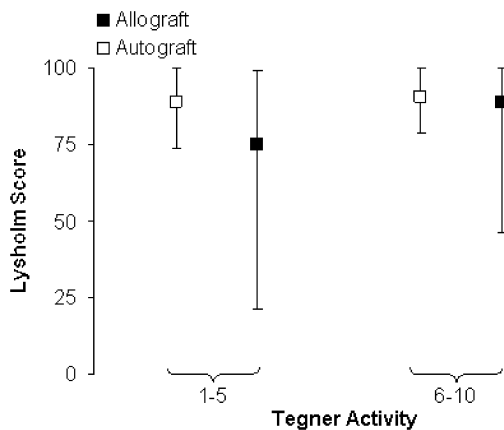| Symptoms	Autograft	Allograft
Limp	4.4/5 (−0.6)	4.4/5 (−0.6)
Support (cane/crutch)	5/5 (0)	4.8/5 (−0.2)
Locking	12.9/15 (−2.1)	12.8/15 (−2.2)
Instability	23.8/25 (−1.2)	20.8/25 (−4.2)
Pain	21.2/2 (−3.8)	19.3/25 (−5.7)
Swelling	8.3/10 (−1.7)	8.4/10 (−1.6)
Stair-climbing	9.5/10 (−0.5)	9.0/10 (−1.0)
Squatting	4.6/5 (−0.4)	4.4/5 (−0.6)
Total	89.7/100 (−10.3)	83.9/100 (−16.1)

Fig. 2 Comparison between the autograft- and allograft-reconstructed patients with respect to physical and sports activity. Average Lysholm score is shown, with *error bars* representing maximum and minimum values of the particular group. Tegner's activity 1–5: low activity; Tegner's activity 6–10: high activity

Functional results were assessed using IKDC final scoring focusing special attention on subjective assessment, symptoms such as swelling, pain, instability, range of motion, and ligament evaluation (Lachmann, pivot shift, medial, and lateral joint opening). No significant difference was found between the two groups. Lachmann test was more often slightly positive in the autografted group, and lack of full flexion was more frequently found among the autograft recipients (7/26 versus 13/53). The differences were, however, not statistically significant. Interestingly, extension deficit was uncommon in both groups. Only one patient (in the allograft group) had an extension deficit above 5°. Severe complaints were rare. Except for three patients in the allograft group, none complained of serious instability or swelling.

In three patients (two with allograft and one with autograft), revision of the reconstruction was performed due to rupture and dysfunction of the ligament. All had an adequate preceding injury. In three additional patients, a second-look arthroscopy was performed due to new complaints. Meniscal injury was found, and a partial meniscectomy was carried out. There were no infections or virus transmissions reported, and no bacterial infection, immune rejection, resorption, or immunsynovitis occurred during the follow-up. In one patient, the allograft ruptured during the implantation procedure just prior to fixation. The implant split in the middle section of the ligament without adequate direct force. This implied that certain degeneration must have been present in the donor ligament itself. To avoid further complications, all BTB specimens from the aforementioned donor were discarded.

Discussion

In the American population, the annual incidence of acute ACL rupture is estimated to be 1/3,000 [4]. Several normal structures in and around the knee have the ability to compensate for the injury, and this may account for the fact that some patients have nearly normal knee function in the absence of an intact ACL. In other patients who have symptoms of a torn ACL, either the compensatory structures are damaged themselves or they are mechanically inadequate to compensate for the loss [21].

There is still a debate on the best choice of grafts for ACL reconstruction. Nevertheless, two types of grafts are used most often: either an autogenous BTB graft as the central third of the patellar ligament or an autogenous graft involving the semitendinosus or gracilis hamstring tendons. Each of these has certain advantages and weaknesses. However, the different grafts appear to produce more or less similar clinical results with respect to subjective evaluation or functional scores. Removal of tissue for BTB autograft has been shown to cause quadriceps weakness with a relatively slow recovery [8] and possible prepatellar pain syndrome postoperatively [12, 13]. Recent animal studies have shown significant lengthening of the patellar tendon 1 year after BTB harvesting [5], which also must be taken into consideration. On the other hand, hamstring tendon harvest may result in atrophy and decreased flexor function [7]. As most ACL injuries occur in sportsmen/sportswomen, postoperative muscle strength and function is of great importance.

When using BTB allografts, most of the abovementioned complications can be precluded. The patella tendon remains intact causing no quadriceps weakness, and donor-site pathology (anterior knee pain) develops infrequently (patella is untouched). In addition, BTB allograft is the first choice for ACL reconstruction in some circumstances, such as in patellofemoral conditions, multiple ligamentous injuries, failed reconstruction, older patients, or small patellar tendon. Furthermore, mechanical and histological studies in animal models comparing the short- and long-term results between autografts and allografts have shown that by the end of the first year, no significant differences are present. [9, 18]

Because we have easy and relatively cheap access to the fresh-frozen BTB allograft in our clinic [22], patients are offered the option of BTB allografts for reconstruction of the torn ACL even when autogenous BTB grafting could

be used. Since the decision is absolutely in accordance with the patient's preference, the two groups in our study were eligible for retrospective clinical assessment. Comparative studies focusing on the late functional and subjective results in BTB autografting and allografting are relatively rare [11, 14, 15, 19]. We examined 79 patients with an average follow-up of 35 months and found no significant differences between the two groups regarding functional and subjective satisfaction level. In both groups, the majority of patients found the result excellent or good. This is in accordance with other studies, which concluded that BTB allografts are adequate alternatives for ACL reconstruction [14].

We saw only one intraoperative complication (the rupture of the allograft when the tendon was pulled into place), which occurred in the allogeneic group, and we found no similar report in the literature. Interestingly, the characteristic of the bony part of this particular BTB graft and the other specimens from the same donor also seemed fairly "unhealthy." The consistence of the bone was unusually soft, and the tendon was easy to tear with the bare hand. Since all allografts are prepared under standard circumstances, we believe the donor might have suffered from some undiagnosed disease affecting the musculo-skeletal system. Unfortunately, no histological assessment was carried out on the remaining specimens, thus only a putative diagnosis can be made.

Among patients and even surgeons, concerns still linger regarding the transmission of viral diseases, with special aversion towards HIV. According to the Centre for Disease Control and Prevention's estimation, at present 8–900,000 people are living in the US with HIV. In comparison to this estimated seroprevalence in the United States (0.35%), in Hungary—as announced by the Hungarian Epidemic Information Centre in 2003—the HIV seroprevalence is estimated to be about 0.03%. Other authors already calculated the risk of HIV transmission from adequately screened and studied donors[2, 23]. Based upon these results and due to the new and improved virus screening test with shortened window period (10–20 days), we estimate that the chance of HIV transmission by the graft can be as low as 1:18,000,000. Furthermore, knowing from other studies that virus transmission is less likely by fresh-frozen specimens [2, 3], the chances are even lower —approximately 1:90,000,000. The rate of anesthetic-related mortality described in the Confidential Enquiry into Perioperative Deaths (CEPOD) was 1 in 185,000 patients [1]. According to this calculation, the concern of HIV transmission by allograft is practically negligible.

In summary, we found that BTB allograft is a good alternative to BTB autografts, and we believe that wherever it is available, it could be offered to the patients as a comparably good and categorically safe method, even for primary ACL reconstruction.

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