

A COMPARISON OF FRESH-FROZEN ALLOGRAFT AND AUTOGRAFT RESULTS IN ARTHROSCOPIC ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

Artroskopik Ön Çapraz Rekonstrüksiyonlarında Taze donmuş Allogreft ile Ototreft Karşılaştırması

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ABSTRACT

Objective: This study's goal was to make a comparison of clinical outcomes between anatomic anterior cruciate ligament (ACL) reconstruction with fresh-frozen allograft and anatomic ACL reconstruction with autograft.

Material and Methods: The retrospective results of 87 patients, who had undergone ACL reconstruction with fresh-frozen allograft (n=49) or autograft (n=38), were included in the study. While preoperative and postoperative levels of activity were assessed using the Tegner activity scale, the functional status was used by the Lysholm knee score. The preoperative and postoperative Lachman test, pivot shift test, and anterior drawer test were used to evaluate clinical instability.

Results: The patients' mean age was 28.3±7 years (16-49). There were 87 male patients. The average time between the ACL injury and surgery was 13.4 months (2 months-10 years). The Lysholm knee score, Tegner activity score, and instability test results were satisfactory compared with the preoperative values, and no significant difference was determined between the two groups (p>0.05).

Conclusion: There was no difference between ACL reconstructions with fresh-frozen allograft and autograft in terms of the studied parameters.

Keywords: Arthroscopy; Anterior Cruciate Reconstruction; ACL; Fresh-Frozen Allograft; Autograft

ÖZET

Amaç: Bu çalışmanın amacı; taze donmuş allogreft ile anatomik ön çapraz bağ (ACL) rekonstrüksiyonu ile otogreft ile anatomik ACL rekonstrüksiyonu arasındaki klinik sonuçların karşılaştırmasını yapmaktır.

Gereç ve Yöntemler: Taze donmuş allogreft (n=49) ve otogreft (n=39) ile ACL rekonstrüksiyonu yapılmış 87 hastanın retrospektif sonuçları çalışmaya dahil edildi. Preoperatif ve postoperatif aktivite düzeyleri Tegner aktivite skalası ile değerlendirilirken, fonksiyonel durum Lysholm skoru ile değerlendirildi. Klinik instabiliteyi değerlendirmek için preoperatif ve postoperatif Lachman testi, pivot shift testi ve öne çekmece testi kullanıldı.

Bulgular: Hastaların yaş ortalaması 28,3±7(16-49) idi. Seksen yedi erkek hasta çalışmaya dahil edildi. ACL yaralanması ile cerrahi arasında geçen süre 13,4 (2 ay-10 yıl) aydı. Lysholm diz skoru, Tegner aktivite skalası, instabilite testi sonuçları preoperatif değerlere göre tatminkardı ve iki grup arasında anlamlı bir fark saptanmadı (p>0,05).

Sonuç: Çalışılan parametreler açısından taze donmuş allogreft ve otogreft ile ACL rekonstrüksiyonları arasında fark görülmedi.

Anahtar Kelimeler: Artroskopi; Ön Çapraz Bağ Rekonstrüksiyonu; ACL; Taze Donmuş Allogreft; Ototreft

INTRODUCTION

Anterior cruciate ligament (ACL) injuries represent the most common ligament injuries in the knee joint (1-3). The main goal of ACL surgeries is to obtain a knee joint with sufficient limitation of motion, resulting in the stability of the ligament and delaying or preventing the cartilage and meniscal injuries in the knee joint (4). The grafts used for a reconstruction of the ACL should have the same quality as the intact ACL, which should be easy to obtain, integration, improve the healing process, and adapt quickly. Allografts have the advantage of shortening the duration of surgery, not having problems with the width of the graft, and not causing donor morbidity, but they have the disadvantage of the high supply cost (5-8).

The aim of this study is to provide a new perspective on the comparison of allograft and autograft anterior cruciate ligament repair in the literature. This study's goal is to make a comparison of the outcomes of anatomic anterior cruciate ligament reconstruction with fresh-frozen allograft and autograft.

MATERIAL AND METHOD

This study was approved by Ethics Committee of University of Cumhuriyet with the number 2016-5/31. Informed consent was obtained from patients participating in the study.

All surgeries were performed by a single surgeon. Patients who underwent anatomical ACL reconstruction in our orthopaedics and traumatology clinic between January 2011 and January 2016 were retrospectively reviewed. A total of 87 patients were included in the study. Since this study was designed as a retrospective manner, our hospital records were not include the type of allograft. Inclusion criteria were age 16 years and older, patients with ACL tear detected on magnetic resonance imaging (MRI). Exclusion criteria were inflammatory arthritis, history of knee surgery for any reason, revision ACL reconstruction, history of cartilage surgery, meniscal transplantation. All the patients were enrolled in the study, which covered the history of trauma, physical examination, and the radiological diagnosis of an ACL failure. All of the patients were informed that their information would be used for scientific purposes. Functional assessments was performed by the same physical therapist using the Lsyholm knee score.

The ACL tear was confirmed by physical examination, magnetic resonance imaging (MRI), and arthroscopic examination. Concomitant meniscus and/or cartilage lesions were fixed before the ACL reconstruction. A partial or total meniscectomy was performed. However, the meniscus was so damaged that it could not be repaired. The semitendinosus and gracilis tendons were used as autografts.

All procedures were performed with the patient in the supine position. A three-centimeter vertical incision was used over the distal attachment site, and the tendons were identified. They were isolated and released from their tibial insertion. Each tendon was sutured with a non-absorbable suture (no: 2) and removed with a tendon stripper. The femoral tunnel was guided instead of the anatomic footprint ACL and drilled according to the standard EndoButton technique. The tibial tunnel was drilled through the anatomic tibial footprint site of the ACL. The femoral and tibial tunnel diameter was identified over the tendon diameter. The same procedures were performed in allograft patients without tendon harvesting. Femoral fixation was performed with EndoButton-CL in the knee hyperflexion position. The EndoButton was shown to be in the proper position by fluoroscopy. Before the tibial fixation procedure, the knee was flexed and stretched 20 times to allow the graft to be in the proper tension. While the final tibial fixation was performed using absorbable screws (1 mm larger than the tunnel diameter) and staples, the knee was approximately 15-20 degrees in flexion. A Hemovac drain was placed, and the wound was closed. A sterile dressing was applied, followed by elastic bandage, and the hinged knee was immobilized locked in extension.

The rehabilitation protocol is our clinic's standard ACL rehabilitation protocol for both groups. All patients underwent a standard postoperative rehabilitation program starting the day after surgery, depending on the meniscus treatment they received. Patients who underwent meniscus repair and microfracture along with ACL reconstruction were allowed flexion range of motion as follows: up to 30° for the first 2 weeks, up to 60° by the 4th week, and up to 90° by the 6th week, with the aid of a hinged knee brace. After the 6th week, the brace was removed, and full joint range of

to 60° by the 4th week, and up to 90° by the 6th week, with the aid of a hinged knee brace. After the 6th week, the brace was removed, and full joint range of motion (ROM) exercises were initiated. These patients were allowed to touch the ground with their toes for the first 2 weeks, bear 50% weight until the 6th week, and bear full weight after the 6th week. Patients who underwent isolated ACL reconstruction were allowed full range of motion and to bear weight as tolerated. Return to sports was recommended no earlier than 9 months post-surgery, depending on the type of sport and knee function.

During the last follow-up, a clinical evaluation was performed based on the patients' ROM and Lysholm knee score. The revised Lysholm score was used in the study. Measurements were performed by the same physical therapist, independently of the evaluation group. The person conducting the evaluation was blind. In accordance with the Lysholm knee scoring system, 100 to 95 scores were considered as excellent values, scores of 94-84 as good, scores of 65-85 as moderate, and scores of <65 as bad values. The physical examination was assessed by instability tests (Lachman, pivot-shift, anterior drawer).

Statistical Analyses

Statistical analyses were performed using IBM Statistical Package for Social Sciences 22.0 (SPSS, Chicago, IL). The Kolmogorov-Smirnov Normality Test was used to assess the conformity of variables to a normal distribution. Based on this result, the Independent t-test (for normally distributed variables) or the Mann-Whitney U test (for non-normally distributed variables) was applied to compare the mean scores of the two groups. Continuous data are presented as mean ± standard deviation (min-max) or median (Q1-Q3), and categorical data are presented as percentages. Statistical significance was set at p<0.05.

RESULTS

The data of 113 patients who underwent surgery for ACL tear in our clinic were scanned retrospectively and 26 patients with missing file information were excluded from the study and 87 patients with no missing data were included in the study. ACL reconstruction was performed in 38 (43.6%) patients using autografts and

in 49 (56.3%) patients using fresh-frozen allografts.

In the fresh-frozen allograft group (group 1), 49 patients were male. The patients' mean age was 28.27 years (±6.89, range: 16-49 years). The mean follow-up period was 7.4 months (the range of 2.1-21.7 months). The period between the trauma and surgery was 12.5 months (the range of 2 months-9 years). In the autograft group (group 2), 38 patients were male. The patients' mean age was 28.5 years (the range of 18-49±7.39 years). The mean follow-up period was 5.8 months (the range of 5.7-25.6±4.59 months). The period between the trauma and surgery was 13.8 months (the range of 2 months to 10 years).

Accompanying injuries and treatment modalities applied in all patients are presented in the table (Table 1). A microfracture repair was performed in one patient in the group 2 and 3 patients in the group 1 due to cartilage lesions. The Lysholm knee score was used to assess the functional activities of the patients. The mean preoperative Lysholm knee scores were 68.84±5.38 in patients in the group 2 and 66.49±6.92 in patients in group 1. The mean postoperative Lysholm knee scores were 90.4±5.73 in patients in the group 2 and 91.88±5.04 (76-100) in the fresh-frozen allograft patients. No significant difference was determined between the groups.

Table 1. Patient additional information

	N	%
Form of trauma		
Sport injury	55	63.2
Knee sprain	16	18.4
Fall	16	18.4
Business		
Officer	18	20.7
Worker	22	25.3
Security	16	18.4
Ortisan	15	17.2
Student	14	16.1
Others	2	2.3
Side of leg		

Table 1. Continued		
Right side	46	52.9
Left side	41	47.1
Localization of meniscus lesion		
No lesions	25	28.7
MMPH	31	35.6
LMAH	4	4.6
MMAH + MMPH	22	25.3
MMAH	3	3.4
LMPH	1	1.1
LMAH + LMPH	1	1.1
Meniscus damage grade		
0	26	29.9
1	3	3.4
2	14	16.1
3	36	41.4
4	8	9.2
Cartilage damage grade		
No lesions	72	82.8
MFC G1	3	3.4
LFC G1	1	1.1
MFC G3	5	5.7
MFC G2	6	6.9
Additional injury		
Negative	82	94.3
Positive	5	5.7
Surgical treatments in additional to ACL repair		
Meniscus repair		
Negatif	47	54.0
Repair	13	14.9
Excision	27	31.0
Microfracture		
Negative	84	96.6
Positive	3	3.4

MMPH: Medial meniscus posterior horn, LMAH: Lateral meniscus anterior horn, MMAH: medial meniscus anterior horn, LMPH: Lateral meniscus posterior horn, MFC: medial femoral condyle, LFC: Lateral femoral condyle, ACL: Anterior cruciate ligament

In the present study, the activity levels of the patients were based on the Tegner activity score. The mean preoperative Tegner scores were 2.08±0.94 in patients in the group 2 and 2.33±1.07 in patients in the group 1. The mean postoperative Tegner scores were 5.34±1.38 in patients in the group 2 and 5.39±1.20 in fresh-frozen allograft patients.

No significant difference was found between the groups (Table 2). When the range of motion of the patients was compared in the postoperative period, the flexion was 124.2±3.14° in the group 2 and 124.6±3.61° in the group 1. No statistically significant difference was found between the groups (Table 2). No limitation was found in both groups. Two patients in the allograft group had complications. Arthroscopic lavage and antibiotics were applied to the first patient in the fifth postoperative week due to febrility, swelling in the knee, redness, and temperature increase. The ACL was assessed as intact. There was no problem during the follow-up period. For the second patient with an allograft, antibiotherapy was started in the third postoperative month due to the complaints of the severe flow in the skin in the stapled area. No problems were encountered during the follow-up period.

DISCUSSION

In our cohort, lysholm knee scores, tegner activity scores, postoperative range of motion were similar in patients underwent ACL operations with allograft or autograft applications during one-year follow-up period.

The ACL plays an important role in maintaining the biomechanics and stability of the knee. The most common damage in ligament injuries occurs to the ACL, and its incidence is 1 in 3,000. The incidence of the most common cause of ACL injuries is 80-90% sports injuries. In the present study, the cause of ACL injuries in 73 (82.9%) patients was associated with sports injuries (9-11).

The choice of a graft in ACL reconstruction is one of the subjects currently being discussed, and studies are ongoing to find the most appropriate graft. Patellar tendon grafts are preferred due to the presence of the graft in the bone block, early healing, sufficient mechanical strength, etc. However, they have disadvantages, including donor site morbidity, knee flexion contracture, and knee pain (12,13). While the hamstring tendons are easy to supply, have less knee pain, and have the advantage of being the closest graft to the ACL structure in terms of biomechanics, stiffness, and robustness, the graft has some disadvantages such as softness, a small graft with a single tendon, and long-term bone-soft tissue healing (14,15).

A review of the literature reveals that previous studies examining the effect of hamstring autograft ACL reconstruction on outcomes reported a revision risk of 7-8.6% in cases where the tendon diameter was 8 mm or less (16). Although no definitive ratio has been specified for the ideal graft diameter, studies have reported that graft diameters smaller than 8 mm are associated with a higher graft failure rate due to the biomechanical strength being proportional to the graft diameter (17). Alomar et al. demonstrated in their study that hamstring grafts with a diameter greater than 7 mm have better tensile properties than grafts with a smaller diameter (18). In our study, hamstring autografts used for ACL reconstruction were prepared and used with a minimum diameter of 8 mm or greater. No revision surgery was performed during the follow-up period in any patient in the autograft group. Allografts may experience reduced clinical efficacy following procedures such as irradiation, dehydration, and chemical processing. In particular, studies have reported that irradiation has a dose-dependent adverse effect on graft strength. Irradiated allografts show weaker mechanical properties compared to non-irradiated allografts (17). The allografts in our study were mostly untreated, non-irradiated and were fresh-frozen.

Chondral and/or meniscal lesions can be observed together with ACL injuries. In some studies, the prevalence of meniscal lesions is 35-100%, and the prevalence of chondral lesions is 21-33% (11). Of our patients, 62 (70.4%) had meniscal lesions, and 14 patients (15.9%) had chondral damage. The treatment of concomitant lesions was performed in the same session.

In one of the studies on ACL repair using hamstring autografts, D'Ambrosi et al. reported that 32 patients underwent repair with the hamstring tendon during a 1-year follow-up period, and the average Lysholm score for repair results was 90.7 (19). Williams et al. evaluated the functional outcome and laxity tests in 85 out of 122 patients using hamstring autografts (20). They reported the mean Lysholm knee score as 91. In a meta-analysis including 7 studies, the postoperative mean Lysholm score after reconstruction using hamstring autograft was 89.7 (17). In this research, the average follow-up period of 38 patients who underwent repair with hamstring autograft showed similar Lysholm knee scores when compared to studies with similar follow-up periods to ours. The Lysholm knee score in our study was excellent-good and

moderate (90.2), showing similar functional scores to recent meta-analyses.

Smith et al. performed a single-tunnel, single-bundle ACL reconstruction with anterior tibial tendon allografts in 19 patients with a one-year follow-up period and reported a significant improvement in the Lysholm scores (21). In the study by D'Ambrosi et al., 29 patients underwent allograft repair with 1-year and 2-year follow-up periods, and the mean Lysholm knee scores were reported as 89.3 and 93.7, respectively (19). In our study, 49 patients underwent allograft repair, and when compared to a study with a similar average follow-up period, the postoperative average Lysholm knee score was excellent-good and moderate at 91.7.

Lee et al. reported that the postoperative range of motion of 338 patients undergoing the ACL repair with different graft types (153 patients with an anterior tibial tendon allograft, 60 patients with a bone-patellar tendon-bone allograft, 125 patients with a hamstring autograft) was better in the allograft group. In the study by D'Ambrosi et al., 32 patients underwent hamstring tendon repair with a 1-year follow-up period, and the mean Tegner score was reported as 3.8 (19,22). In the same meta-analysis, which included 7 studies, the postoperative mean Tegner activity score was 6.1 (17). In this research, a higher Tegner activity score (5.3) was observed in studies with a mean follow-up period similar to ours, where repair was performed using hamstring autografts. However, our study had a short follow-up period, which was similar to studies with a 2-year follow-up period.

Previous studies comparing allografts and autografts in ACL reconstruction exist, and it has been reported that there is no significant difference between autograft and allograft tendons in terms of functional and clinical scores in clinical outcomes (23). Cusumano et al. compared the outcomes of 50 patients who underwent ACL reconstruction with allograft and autograft (24). The functional scores of patients followed up for 6 months and 1 year were evaluated using the Lysholm score and Tegner activity scale. No difference was observed between the groups (24). In another study involving 116 patients who underwent ACL reconstruction with allograft and autograft, the authors reported no significant difference between Lysholm and Tegner activity scale scores at the 1-year postoperative follow-up (25).

In our study, the results were consistent with the recently published meta-analysis. In the present study,

the Lysholm knee score and the Tegner activity score of both groups were satisfactory. No significant difference was determined between the groups (Table 2). Following anterior cruciate ligament repair, the long-term stability of the repaired graft in the knee joint and the remodeling of the tendon depend on the tendon’s revascularization and osseointegration status (26). A meta-analysis including 5 studies examining ligament

healing between allograft and autograft reported that ligamentization and cell accumulation occurred more rapidly in repairs using autograft, but that more clinical studies are needed (27). In another study using MRI to evaluate graft maturation and healing radiologically, graft maturation was reported to be better in the autograft group compared to the allograft group (24). In our study, secondary arthroscopy or MRI was not performed to evaluate allograft healing.

Table 2. Comparison of preop and postop scores of allografts (group 1) and autograft (group 2) groups

		Mean ± SD (min-max) or median (Q1-Q3)		p value
		Group 1	Group 2	
Lysholm Knee Score	Preop	66.49±6.92 (50-76)	68.84±5.38 (57-77)	0.175*
	Postop	91.88±5.04 (76-100)	90.42±5.73 (76-100)	0.127*
Tegner Knee Score	Preop	2.33±1.07 (1-7)	2.08±0.94 (1-5)	0.254*
	Postop	5.39±1.20 (3-7)	5.34±1.38 (3-7)	0.846*
Follow-up time	Postop	7.4 (2.1-21.7)	5.8±4.49 (5.7-25.6)	0.335**
Range of Motion	Preop	124±3 (117-130)	125±4 (115-130)	0.398*
	Postop	124.6±3.61	124.2±3.14	0.570*

SD: standard deviation, Q: quartile, Preop: preoperative, Postop: postoperative, *Independent t-test was applied.
 **Mann-Whitney u test was applied

In the literature, extension greater than 10° and flexion limitation greater than 125° have been regarded as the criteria for arthrofibrosis, and their incidence has been reported as 6-14% (11). In the present study, none of the patients had extension restriction. The flexion average was 129.5° in the allograft group and 130.5° in the autograft group. No significant difference was detected between the groups in terms of the range of joint motion (Table 2).

Our results demonstrated that the graft choice has not a crucial impact on the outcome of ACL reconstruction, as emphasized by Atik (28). Allografts may be preferred because of their short surgical time, the lack of donor site problems, being able to use them in an appropriate size, minimum scar, good cosmetic appearance, low postoperative pain, low movement limitation, and less arthrofibrosis. However, disadvantages, such as low biocompatibility, disease transplants, and an expensive and long recovery period, have been reported (5,8). The limitations of this study include its non-prospective nature, the use of allografts in different types of grafts,

and the failure to consider allograft thickness and autograft thickness. Additionally, there was no control group and the follow-up period was short. The fact that postoperative scores were not evaluated against baseline values is considered a limitation of the study.

CONCLUSION

As a result of the present study, when comparing the patients who had undergone ACL reconstruction with both fresh-frozen allografts and semitendinosus/gracilis autografts, the Tegner score and Lysholm knee score showed no difference between the two graft options in terms of the range of motion. Based on the current short follow-up period, the short-term results of both graft types are similar; however, larger, prospective studies are needed.

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