Comparison of Outcomes of Anterior Cruciate Ligament Reconstructions Using Patellar Tendon or Hamstring Tendon Autografts with Femoral Cross-pin Fixation*

Femoral Çapraz Çivi Fiksasyonu ile Patellar Tendon veya Hamstring Tendon Otogrefti Kullanılan Ön Çapraz Bağ Rekonstrüksiyonlarının Sonuçlarının Karşılaştırılması

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Abstract

Aim: In this study, we aimed to compare outcomes of anterior cruciate ligament (ACL) reconstructions using bone–patellar tendon–bone graft (BPTG) or hamstring tendon graft (HTG) with cross-pin fixation at the femoral side.

Materials and Methods: The retrospective observational study included records of 100 patients who underwent ACL reconstruction with femoral cross-pin fixation between May 2008 and August 2012. The patients were divided into two groups according to the graft type used: the BPTG group and the HTG group. The preoperative and postoperative 6th-month Tegner Lysholm Knee Scoring Scale (TLKS) scores, International Knee Documentation Committee Subjective Knee Evaluation Form (IKDC-SKF) scores, and Lachman test results were compared. The effects of meniscus lesion presence on the outcomes were also investigated.

Results: Of the 100 patients, 93 were male and 7 female. The HTG and BPTG groups consisted of 62 and 38 patients, respectively. The mean age was 24.1±4.9 (18–38) years for the HTG group and 32.1±6.8 (21–54) years for the BPTG group. The mean pre- and postoperative TLKS scores were respectively 50.5 and 94.3 in the BPTG group, and 49.9 and 95.2 in the HTG group. The mean pre- and postoperative IKDC-SKF scores were 51.3 and 95.6 in the BPTG group, and 51.8 and 95.6 in the HTG group. The postoperative score improvement was statistically significant in all patients ($p<0.05$), but there was no significant difference between the two groups. The postoperative improvement in knee stability was statistically significant in all patients ($p<0.05$). The postoperative score improvement was less in patients with meniscal injury ($p<0.05$).

Discussion and Conclusion: We found no significant difference between the two groups in terms of functional knee scores. However, the presence of meniscus lesions negatively affects the postoperative outcomes.

Keywords: anterior cruciate ligament reconstruction; bone–patellar tendon–bone autograft; hamstring autograft; orthopedic fixation devices

Öz

Amaç: Bu çalışmada femoral tarafta çapraz çivi fiksasyonu ile kemik–patellar tendon–kemik grefti (KPTG) veya hamstring tendon grefti (HTG) kullanılan ön çapraz bağ (ÖÇB) rekonstrüksiyonlarının sonuçlarını karşılaştırmak amaçlanmıştır.

Gereç ve Yöntemler: Retrospektif gözlemsel çalışmamız Mayıs 2008—Ağustos 2012 döneminde femoral çapraz çivi fiksasyonlu ÖÇB rekonstrüksiyonu uygulanmış olan 100 hastanın kayıtlarını kapsadı. Hastalar, kullanılan greft türüne göre iki gruba ayrıldı: KPTG grubu ve HTG grubu. Preoperatif ve postoperatif 6. ay Tegner Lysholm Diz Skorlama Skalası (TLDS) skorları, Uluslararası Diz Dokümantasyon Komitesi Subjektif Diz Değerlendirme Formu (UDDK-SDF) skorları ve Lachman test sonuçları karşılaştırıldı. Ayrıca menisküs lezyonu varlığının sonuçlar üzerindeki etkisi incelendi.

Bulgular: Yüz hastanın 93'ü erkek, 7'si kadındı. HTG ve KPTG grupları sırasıyla 62 ve 38 hastadan oluştu. Ortalama yaş HTG grubu için 24,1±4,9 (18–38) yıl, KPTG grubu için 32,1±6,8 (21–54) yıl idi. Sırasıyla operasyon öncesi ve sonrası ortalama TLDS skorları KPTG grubu için 50,5 ve 94,3, HTG grubu için 49,9 ve 95,2 idi. Operasyon öncesi ve sonrası ortalama UDDK-SDF skorları KPTG grubu için 51,3 ve 95,6, HTG grubu için 51,8 ve 95,6 idi. Postoperatif skorlardaki yükseliş tüm hastalarda istatistiksel olarak anlamlıydı ($p<0,05$); fakat iki grup arasında anlamlı fark yoktu. Diz stabilitesindeki postoperatif artış tüm hastalarda istatistiksel olarak anlamlıydı ($p<0,05$). Menisküs yaralanması olan hastalarda postoperatif skorlardaki yükseliş daha azdı ($p<0,05$).

Tartışma ve Sonuç: İki grup arasında fonksiyonel diz skorları açısından anlamlı bir fark tespit edilmemiştir. Fakat menisküs lezyonu varlığı postoperatif sonuçları negatif etkilemektedir.

Anahtar Sözcükler: hamstring otogrefti; kemik–patellar tendon–kemik otogrefti; ortopedik fiksasyon cihazları; ön çapraz bağ rekonstrüksiyonu

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INTRODUCTION

Anterior cruciate ligament (ACL) rupture is a common injury in young athletes. Affecting the stability of the knee, it results in "giving way" symptoms in daily or sports activities, increased risk of meniscal tear, and early cartilage degeneration of the injured knee. Accordingly, the goal of ACL reconstruction is to provide appropriate stability and good function and to protect the knee from developing cartilage damage, meniscus tears, and osteoarthritis. The success of ACL reconstruction depends on many factors, including anatomic graft placement, stable bone–graft fixation, and graft strength. These factors are mostly linked to the surgical technique and graft type used. Bone–patellar tendon–bone graft (BPTG) and hamstring tendon graft (HTG) are the most commonly used autografts in ACL reconstruction (1,2). The biomechanical properties of BPTG and HTG have been shown to be comparable on strength examination (3,4). The disadvantages are anterior knee pain-related disability of rehabilitation after surgery, loss of sensation, risk of patellar fracture, quadriceps weakness, and inferior patellar tendon contracture (5,6). Compared to BPTG, HTG is associated with lesser donor site morbidity and anterior knee pain. The disadvantages of HTG include a longer bone graft fusion time and, accordingly, a higher graft elongation rate after the operation (6).

The graft fixation methods used in ACL reconstruction are direct and indirect fixation. Direct fixation materials, such as the interference screw, provide compression between the bone and graft. Indirect fixation (e.g., cross-pin fixation) provides fibrous tissue healing with hanging graft material in the tunnel (7). In recent years, cross-pin fixation has been increasingly used in order to minimize the disadvantages associated with metal screws. It has been shown to be stronger and resistant to graft failure. However, in the literature there have also been reports of fractures of the nail and laterally sliding pieces of broken nail which lead to inflammatory reaction and iliotibial band syndrome (7,8).

In the literature, outcomes of ACL reconstructions using BPTG and HTG were compared and BPTG was generally found to be more favorable than HTG in terms of graft failure (8,9). However, these studies lack standardization based on the femoral fixation method used, which, to our knowledge, can also affect the outcomes of ACL reconstruction. To avoid this confounding factor, in this study we aimed to compare outcomes of ACL reconstructions using BPTG or HTG fixed at the femoral side with the same fixation method (cross-pin fixation).

MATERIALS AND METHODS

The study was a retrospective observational study conducted at the Department of Orthopedics and Traumatology of the Uludag University Medical Faculty between February and September 2012. Patient medical records were reviewed and data of patients who underwent anatomical ACL reconstructions using BPTG and HTG between May 2008 and January 2012 were collected. The inclusion criteria were no history of previous knee surgery or any other ligament injury, use of cross-pin for graft fixation in the femoral tunnel and interference screw in the tibial tunnel, and patient follow-up for at least six months. Patients with a history of multi-ligament injuries, previous knee surgery, or severe osteoarthritic knees with radiographic verification or postoperative complication were excluded. The operations had been performed by the same surgeon and by using the same technique. According to the graft type used, two patient groups were identified: the BPTG group and the HTG group.

Surgical technique

Operations were carried out under regional or general anesthesia and antibiotic prophylaxis with 1.5 g of cefuroxime axetil. The patient was in the supine position. The tourniquet was applied to the thigh. Two to three standard portals (anteromedial and anterolateral) were used for access to the knee joint. In the HTG group, gracilis and semitendinosus tendon harvesting was performed with a 3-cm skin incision in the anteromedial region of the proximal third of the tibia. For BPTG harvesting, anterior midline in-

Table 1. Patient characteristics

	BPTG group	HTG group
Total number of patients	62	38
Mean age at ACL reconstruction (years)	32.1	24.1
Sex (female:male) (n)	3:59	4:34
Meniscal injury (n)	25	12
Mean time between the injury and operation (weeks)	9	9

BPTG: bone–patellar tendon–bone graft; HTG: hamstring tendon graft

Table 2. Preoperative and postoperative 6th-month TLKS scores

TLKS score (interpretation)	BPTG group		HTG group	
	Preop., n (%)	Postop., n (%)	Preop., n (%)	Postop., n (%)
<65 (poor)	62 (100)	-	38 (100)	-
65–83 (fair)	-	-	-	-
84–90 (good)	-	9 (14.5)	-	2 (5.3)
90–100 (excellent)	-	53 (85.5)	-	36 (94.7)

BPTG: bone–patellar tendon–bone graft; HTG: hamstring tendon graft; TLKS: Tegner Lysholm Knee Scoring Scale

Table 3. Preoperative and postoperative 6th-month Lachman test results

(-)		Lachman test results			
		1 (+)	2 (+)	3 (+)	
BPTG group	Preop., n (%)	-	53 (85.5)	2 (3.2)	7 (11.3)
	Postop., n (%)	36 (58.1)	25 (40.3)	1 (1.6)	-
HTG group	Preop., n (%)	1 (2.6)	28 (73.7)	4 (10.5)	5 (13.2)
	Postop., n (%)	28 (73.7)	10 (26.3)	-	-

BPTG: bone–patellar tendon–bone graft; HTG: hamstring tendon graft

Table 4. Comparison of the preoperative and postoperative 6th-month TLKS score, IKDC-SKF score, and Lachman test result differences between the BPTG and HTG groups

Functional scores	BPTG group	HTG group
TLKS score improvement, mean±SD	43.9±5.5*	45.3±3.0*
IKDC-SKF score improvement, mean±SD	44.4±4.5†	43.8±3.9†
Lachman test result improvement, mean±SD	1.35±0,62§	1.34±0,57§

*,†,§ paired samples t-test, p>0.05

BPTG: bone–patellar tendon–bone graft; HTG: hamstring tendon graft; IKDC-SKF: International Knee Documentation Committee Subjective Knee Evaluation Form; SD: standard deviation; TLKS: Tegner Lysholm Knee Scoring Scale

Table 5. Comparison of the preoperative and postoperative 6th-month TLKS score, IKDC-SKF score, and Lachman test result differences between patients with or without meniscus lesions in the BPTG and HTG groups

Functional scores	BPTG group			HTG group		
	ML (+)	ML (-)	p*	ML (+)	ML (-)	p*
TLKS score difference, mean±SD	41.6±6.8	45.2±3.9	0.024	40.3±5.1	45.7±2.8	0.041
IKDC-SKF score difference, mean±SD	40.8±5.5	45.1±3.5	0.035	41.3±5.0	46.7±3.4	0.03
Lachman test result difference, mean±SD	1.3±0.4	1.2±0.5	0.124	1.3±0.2	1.4±0.3	0.196

* independent samples t-test

BPTG: bone–patellar tendon–bone graft; HTG: hamstring tendon graft; IKDC-SKF: International Knee Documentation Committee Subjective Knee Evaluation Form; ML: meniscus lesion; SD: standard deviation; TLKS: Tegner Lysholm Knee Scoring Scale

cision was made from the inferior pole of the patella to the tibial tubercle and patellar tendon was harvested by using oscillating saw and osteotome. The femoral and tibial tunnels were drilled with a reamer that corresponds to graft diameter and then the RigidFix Cross Pin guide frame (DePuy Mitek) was inserted in the femoral tunnel. The sleeves of the RigidFix frame were checked to be at the center of the lateral femoral condyle. Slow and gentle drilling was done. At this point it is important to check by arthroscope that the guide wire will be placed in the center of the femoral tunnel. The RigidFix guide frame was detached and removed. The graft was placed into the femoral tunnel and fixed with two bioabsorbable cross pins (DePuy Mitek). Bioabsorbable Intrafix screw (DePuy Mitek) was used to fix the graft at the tibial tunnel. The wound was closed in layers.

Data collection tools

Patient demographic characteristics as well as preoperative and postoperative 6th-month Tegner Lysholm Knee Scoring Scale scores, International Knee Documentation Committee Subjective Knee Evaluation Form scores, and Lachman test results were obtained.

The Tegner Lysholm Knee Scoring Scale (TLKS) assesses the patient's knee symptoms and functions during the past four weeks in eight sections: limp, support, pain, instability, locking, swelling, stair climbing, and squatting. Translation of the total score of the scale is as follows: <65 is poor, 65–83 is fair, 84–90 is good, and >90 is excellent.

The entire International Knee Documentation Committee (IKDC) form includes a demographic form, current health assessment form, subjective knee evaluation form (SKF), knee history form, surgical documentation form, and knee examination form, which, as the IKDC suggests, may be used separately. In our study, we obtained IKDC-SKF scores. The IKDC-SKF consists of three sections: symptoms, sport activities, and function, which assess the highest level of activity and pain during the past four weeks. The IKDC-SKF score is calculated as (sum of items) / (maximum possible score) x 100, and interpreted as a measure of function, higher scores representing higher levels of function and lower levels of symptoms. The maximum possible score is 87.

The Lachman test measures the degree of anterior tibial translation on the femur. Our study included knee laxity evaluation because knee laxity data as Lachman test results were available in the patients' records. All patients were examined by the same surgeon. Patients lay down in the supine position and put the knee in about 20–30 degrees flexion. The examiner placed one hand's thumb on the tibial tuberosity and other fingers behind the tibia and the other hand on the patient's thigh. While pulling the tibia anteriorly, forward translational movement of the tibia was observed, the amount of translation was compared with the normal knee and the differences were recorded. Interpretation of the Lachman test laxity results is as follows: (-) is normal, 1 (+) is 0 to 5 millimeter more anterior tibial translation compared to the normal side, 2 (+) is 5 to 10 mm more anterior tibial translation compared to the normal side, and 3 (+) is >10 mm more anterior tibial translation compared to the normal side (10).

Study ethics

The study protocol was approved by the Clinical Research Ethics Committee of the Uludag University Medical Faculty (approval no. 31.01.2012-3/39).

Statistical analysis

Statistical analyses were performed using the IBM SPSS 21.0 software package. Normal distribution was assessed by the one-sample Kolmogorov-Smirnov test. The descriptive statistics were calculated. The BPTG and HTG groups were compared with the t-test. The pre- and postoperative test result differences within the groups were compared using the paired samples t-test. To compare the pre- and postoperative test result differences between patients with or without meniscus lesions within the groups, the independent samples t-test was used. $p<0.05$ was considered statistically significant.

RESULTS

We initially reviewed the records of 257 patients. Of them, only 100 were found to meet the inclusion criteria. Of these 100 patients (93 males, 7 females), 62 formed the BPTG group and the remaining 38 the HTG group. The mean age at the time of operation was 32.1 (21–54) years in the BPTG group and 24.1 (18–38) years in the HTG group. The mean follow-up was 7.7 (6.4–10.4) months. In the BPTG group, 25 patients had meniscopathy with a history of partially resected meniscus, while in the HTG group 12 patients had meniscal tear with a history of partially resected meniscus (Table 1).

No other ligament injury or articular damage of greater than one-half the thickness of the articular cartilage was observed during arthroscopy. The preoperative TLKS scores were <65 (i.e., poor function) in all patients. The mean preoperative IKDC-SKF score was 51.5. The preoperative Lachman test results were 1 (+) in 51% of the patients. All test results improved after surgery (Table 2 and Table 3).

The preoperative and postoperative 6th-month TLKS score, IKDC-SKF score, and Lachman test result differences were compared between the BPTG and HTG groups. The postoperative score improvement was statistically significant in all patients ($p<0.05$), although there was no statistically significant difference between the BPTG and HTG groups (Table 4).

The preoperative and postoperative 6th-month TLKS score, IKDC-SKF score, and Lachman test result differences were also compared between the patients with or without meniscus lesions in each group. The TLKS and IKDC-SKF score improvements were greater in patients who had no meniscus lesion ($p<0.05$). However, no such difference was observed in terms of Lachman test result differences ($p>0.05$) (Table 5).

DISCUSSION AND CONCLUSION

In this study, we found that ACL reconstructions using BPTG and HTG with cross-pin fixation had similar satisfactory outcomes, and that the presence of meniscus lesions could negatively affect the functional score improvement after ACL reconstruction.

Many types of grafts have been used in ACL reconstructions. The literature contains various studies comparing the results of ACL reconstructions with different types of grafts (11,12). BPTG is widely used for adequate mechanical strength for graft fixation and early recovery. A meta-analysis reported that BPTG was found to be superior to HTG in morphology at second-look arthroscopy, though with no significant difference in clinical outcomes (13). The disadvantages of BPTG are donor site morbidity, especially anterior knee pain, and flexion contracture (14). The disadvantage of HTG is elongation, which usually occurs in the postoperative period. Accordingly, more time is required for graft–bone healing, graft fixation may be less secure, and expansion can occur in the tunnel (15). Previous research has almost exclusively focused on ACL reconstructions with BPTG and HTG and reported no significant difference in the postoperative period in terms of clinical evaluation of knee stability (16,17). A meta-analysis by Freedman et al. of 34 studies evaluated the results of 1976 ACL reconstructions using BPTG and HTG and reported less graft re-rupture, less laxity, greater patient satisfaction, and more anterior knee pain in BPTG use (18). In our study, we compared the preoperative and postoperative 6th-month functional scores of our BPTG and HTG groups, and observed similarly improved scores in both groups.

Measurements of knee instability in clinical trials can be quantitative (e.g., arthrometer testing) or qualitative (pivot shift test, Lachman test). A meta-analysis by Yunes et al. reported greater laxity in HTG than in BPTG, based on arthrometer testing evaluation (19). In our study, one of the factors investigated was laxity, compared using the Lachman test. The postoperative improvement in knee stability was statistically significant in all patients, although there was no significant difference between the two groups.

Many techniques have been developed for femoral graft fixation in ACL reconstruction. Graft fixation with the cross-pin technique has been shown to be superior to the interference screw technique and the suspensory systems in terms of biomechanics (20). In cross-pin fixation, 2 soluble nails are placed in the femoral tunnel, where they are central and perpendicular to the tunnel. Zantop et al. reported that a cross-pin system placed transversely to the tunnel was superior to the interference screw (21). Gorschewsky et al. reported a higher rate of bone–graft healing for cross-pin fixation than for interference screw fixation, especially in BPTG use. This is because of the bone block to be in contact with the tunnel in 360˚ and less damage to the graft during fixation (22). Marder et al. compared two groups of patients who underwent ACL reconstruction using patellar and hamstring tendon grafts fixed with different suspensory systems and observed no statically significant difference in the results (23). Aglietti et al. compared ACL reconstructions using HTG and BPTG fixed with a suspensory system. At the end of a 28-month follow-up, they found a statistically significant difference in favor of BPTG in terms of postoperative outcomes (24). In our study, we used the cross-pin method for femoral graft fixation in all patients and did not find any difference in outcomes between the BPTG and HTG groups. The possible disadvantages of cross-pin fixation are biomechanical weakness, high costs, and adverse reactions in some cases. Complications associated with these disadvantages are expansion of the tunnel, breaking of the nail, drifting of broken nail parts into the tunnel, loosening of the graft, and need for revision (25,26). In our study, our patients did not develop any of these complications.

Meniscal and chondral injuries are associated with 36% of ACL tears at the time of reconstruction (27,28). Previous research has reported that patients who present with a focal cartilage injury or have a history of meniscectomy have more rapid progression of osteoarthritis from the baseline examination at the time of primary ACL reconstruction (28,29). Cinque et al. designed a study to determine the effects of meniscal lesion presence on ACL reconstruction outcomes, and reported that meniscal lesions did not affect the short-term postoperative outcomes (30). In our study, we investigated these effects in two patient groups based on the graft type used and demonstrated in both groups that patients with both ACL injury and meniscal lesions showed less improvement in the postoperative 6th-month TLKS and IKDC-SKF scores compared to those with no meniscus lesion. However, there was no difference between the patients with and without meniscus lesions in terms of knee laxity improvement.

The main strength of our study is that we used the data of patients whose surgeries were performed by the same surgeon and using the same operative technique and whose grafts were fixated with the same material. This allowed us to compare the results in terms of graft type only and avoid the possible confounding of surgeon-related factors.

The major limitations of our study are the small sample size, the disproportionate sex distribution of subjects, and the laxity measurement method used, which was the Lachman test. Arthrometer-based evaluations might be more objective.

In this study, we compared outcomes of treatment with BPTG and HTG as the two most commonly used types of autografts in ACL reconstruction. Our study results showed that ACL reconstructions using BPTG and HTG had similar favorable clinical outcomes, and that femoral cross-pin fixation was a satisfactory and reliable method for graft fixation. However, the presence of meniscus lesions can affect the outcomes negatively. Long-term follow-up studies with larger samples are needed to confirm our results and conclusions about the safety of the cross-pin fixation method.

Conflict-of-Interest and Financial Disclosure

The authors declare that they have no conflict of interest to disclose. The authors also declare that they did not receive any financial support for the study.

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