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A comparison of clinical outcome of augmentation and standard reconstruction techniques for partial anterior cruciate ligament tears

Parsiyel ön çapraz bağ yırtıklarının tedavisinde destekleme ve standart rekonstrüksiyon tekniklerinin klinik sonuçlarının karşılaştırılması

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Objectives: This study aims to compare the clinical outcome and possible complications of augmentation technique and standard reconstruction for the treatment of partial anterior cruciate ligament (ACL) tears.

Patients and methods: Forty patients (36 males, 4 females; mean age 30 years; range 19 to 40 years) who underwent surgery due to ACL tear were included in this prospective randomized study. The patients were randomly divided into two groups, including 20 patients in each group. The patients in the group 1 underwent standard single bundle ACL reconstruction with hamstring tendon autografts, while those in the group 2 underwent augmentation where the remaining remnant ACL was not sacrificed, but instead augmented with hamstring tendon autograft as in the standard reconstruction technique. The mean follow-up was 24.3 months (range; 21-28 months). Clinical outcomes were evaluated using International Knee Documentation Committee (IKDC), Lysholm scores, physical instability tests and patient satisfaction questionnaires. The complication rates of both groups were compared. Tibial and femoral tunnel widening were assessed using lateral and anteroposterior radiographs.

Results: No significant differences were found between the groups in terms of IKDC, Lysholm scores, physical instability tests, patient satisfaction questionnaires and incidences of Cyclops lesions and arthrofibrosis. Tibial and femoral tunnel widening was less in the augmentation group. This difference was more significant on the tibial side.

Conclusion: In the repair of partial ACL tears, augmentation technique is as effective as the standard technique, leading to, less tunnel widening evidently in the tibial tunnel, particularly.

Key words: Anterior cruciate ligament; arthroscopy; augmentation; partial tear; tunnel widening.

Amaç: Bu çalışmada parsiyel ön çapraz bağ (ÖÇB) yırtıklarının tedavisi için destekleme tekniği ve standart rekonstrüksiyonunun klinik sonuçları ve muhtemel komplikasyonları karşılaştırıldı.

Hastalar ve yöntemler: Bu prospektif randomize çalışmaya parsiyel ÖÇB yırtığı nedeniyle cerrahi uygulanan 40 hasta (36 erkek, 4 kadın; ort. yaş 30 yıl; dağılım 19-40 yıl) dahil edildi. Hastalar 20 kişiden oluşacak şekilde randomize olarak iki gruba ayrıldı. Grup 1'de hastalar hamstring tendon otogrefti kullanılarak standart tek band ÖÇB onarımı ile tedavi edilirken, grup 2'de bağ artığının temizlenmesi yerine, korunup hamstring tendon otogrefti ile standart onarım yapar gibi destekleme tekniği uygulandı. Ortalama takip süresi 24.3 ay (dağılım; 21-28 ay) idi. Cerrahinin klinik sonuçları Uluslararası Diz Dokümantasyon Komitesi (IKDC), Lysholm skorları, fiziksel instabilite testleri ve hasta memnuniyet anketleri ile değerlendirildi. Her iki grubun komplikasyon oranları karşılaştırıldı. Tibial ve femoral tünel genişlemesi yan ve ön-arka grafiler ile değerlendirildi.

Bulgular: Her iki grup arasında IKDC ve Lysholm skorları, fiziksel instabilite testleri, hasta memnuniyet anketleri ve Siklops lezyon ve artrofibrozis komplikasyonlarının görülme sıklığı yönünden anlamlı fark saptanmadı. Tibial ve femoral tünel genişlemesi destekleme grubunda daha azdı. Bu farklılık tibial tarafta daha belirgindi.

Sonuç: Parsiyel ÖÇB yırtıklarının onarımında destekleme tekniği standart teknik kadar başarılı bir yöntem olup, tünel genişlemesi tibial tünelde daha belirgin olmak üzere daha azdır.

Anahtar sözcükler: Ön çapraz bağ; artroskopi; destekleme; parsiyel yırtık; tünel genişlemesi.

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A partial tear of the anterior cruciate ligament (ACL) tear is a very common injury, with its frequency ranging from 10-35% in different series.[1] Partial ACL tears may appear in different pathologic forms. A complete tear of one of the two bundles, or an increase in vascularity of the ACL fibers as in intrasubstantial ruptures may be defined as partial tears. Arthroscopic visualization and evaluation of partial ACL tears, especially those of intrasubstantial tears, is not always possible.[2] Another method of grouping partial tears is by referring to which of the bands is ruptured, anteromedial (AM) or posterolateral (PL). However, the AM bundle often obscures the PL bundle and the ACL double bundles are not readily seen during arthroscopy.[3]

In partial tears, if remnant ACL bridging between the tibia and the femur is in the axis of the AM bundle and more than half of it is intact; the augmentation technique can be applied. In this technique remnant ACL is preserved instead of being debrided, and reinforced with hamstring autograft similar to ACL reconstruction. The advantages of this technique include; enhanced revascularization and ligamentization of the graft, preservation of proprioceptive cells, prevention of synovial fluid bath to the tunnels, enhanced bone-tendon healing, and early rehabilitation.[4-7] Furthermore, accurate tunnel placement is easier with this technique than the standard technique. However, the surgery is technically more demanding, and related to increased impingement and cyclops lesion incidence.

Our hypothesis is that the clinical outcome of the augmentation technique is as favorable as the standard ACL reconstruction with hamstring tendon autograft and potential complications are not more common than the standard technique. We aimed to compare the clinical outcome and complications of augmentation technique and standard reconstruction for partial ACL tears.

PATIENTS AND METHODS

This prospective study was performed between November 2005 and March 2008, following ethics committee approval. Patients who were diagnosed with partial ACL tear by physical examination and magnetic resonance imaging (MRI), patients whose arthroscopic examination revealed an ACL with more than $^1/_2$ of its integrity preserved, bridging the tibia and femur, and elongated no more than $^1/_2$ of its length were included. The torn sections of the ACLs belonged with the PL bundle, the intact sections with the AM bundle. Other inclusion criteria were normal alignment, normal contralateral knee and willingness to join the rehabilitation program. Patients with arthrosis, grade 3-4 chondral damage, rotatory instability and history of previous knee surgery or fracture around the knee were excluded. Those who had injuries in addition to meniscus tears that could be treated with simple partial menisectomy were excluded from the study.

After informed consents were obtained, patients were randomized intra operatively, into two groups; standard transtibial single bundle ACL reconstruction group where remnant tissue is removed and ACL is reconstructed with hamstring autograft, or augmentation group where remnant ACL is preserved and augmented with hamstring autograft. The first group was composed of 20 patients (18 males, 2 females; mean age 31 years; range 19 to 40 years). The second group consisted of 20 patients (18 males, 2 females; mean age 28 years; range 21 to 36 years).

The patients underwent surgery no earlier than three weeks after the ACL tear. At this time patients were placed into rehabilitation with the purpose of achieving painless and near-complete range of motion. The AM and AL portals were opened. The present remnant ACL was examined to evaluate if it matched the prerequisite criteria. In augmentation technique: at first, the tibial drill guide tip was placed under the tibial attachment part of the AM bundle of the ACL and at the median side of the external tibial tuberosity and 2-3 mm posterior to the AM attachment site. The tibial tunnel entrance was placed on the tibial cortex as medial as possible. Thereafter, the tibial tunnel was drilled over the drill pin with a drill.

The femoral insertion site around the remnant ACL was carefully cleaned. Placement of the drill pin for the femoral tunnel was based on between the insertions of the PL and AM bundles. Thereafter, the remnant ACL was pulled to the AM side with a probe, the femur drill passed near the remnant bundle and the femoral tunnel was opened at the intended place, preserving the femoral attachment point of the AM part of the remnant bundle. In both techniques femoral fixation was performed with a cross-pin system (Sling Shot, DePuy Mitek) and tibial fixation with a screw.

Patients were rehabilitated within a special program for 4-6 months. In the early postoperative period, they were instructed to use crutches and braces. Sports activities were permitted on an average of 4-6 months later.

Clinical outcomes of both techniques were compared using International Knee Documentation Committee (IKDC) and Lysholm scores, range of motion (ROM), Lachman, pivot-shift tests and patient satisfaction. The incidence of arthrofibrosis was evaluated according to the Shelbourne classification.[8] Femoral and tibial tunnel widening was assessed by

comparing lateral and AP radiographs taken in the early postoperative and at the last follow-up. Femur and tibial tunnel width at the widest point and at 1 cm from aperture of the tunnels were measured by a radiologist, and corrected for magnification. Differences between the early postoperative and the last follow-up were recorded.

The sample size of each group was determined beforehand using statistical power analysis. Sample sizes of 20 patients were calculated to yield more than 0.80 statistical power and the study groups were arranged accordingly. The independent sample t-test, Fisher exact and Chi-square tests were used as statistical analyses. P<0.05 was considered statically significant.

RESULTS

Mean follow-up was 24.3 months (range, 21-28 months). Mean time from trauma till ACL reconstruction was 2.3 months (range, 1-4 months) in the augmentation group and eight months (range, 4-13 months) in the standard reconstruction group.

There was no significant difference between the groups in terms of improvement of IKDC (p=0.90) and Lysholm scores (p=0.94). All the patients in both groups had firm end points and there was no significant difference between the two groups in terms of final follow-up Lachman and postoperative pivotshift (p=0.5, p=0.5) There was no significant difference between the two groups in terms of ROM, patient satisfaction and mean preoperative quadriceps circumference differences between the intact and reconstructed knee (p>0.05) (Table I). Tibial and femoral tunnel widening was lower in the augmentation group (p=0.001, p=0.03 respectively). This difference was more significant on the tibial side. While tibial tunnel width increased from 7.40 + 0.50 to 7.9 + 0.50 in the standard technique group, patients in the augmentation group had tibial tunnel widening of only 18 mm. (7.50 + 0.51 to 7.68) (p=0.001) (Table II).

Fourteen of the patients in the augmentation group were satisfied, four patients were nearly satisfied, and two were unsatisfied. Sixteen of the patients in the control group were satisfied and four patients were nearly satisfied (p=0.45>0.05).

One patient in the augmentation group developed Cyclops lesion confirmed by MRI. Conservative therapy was not successful and a second look arthroscopy was required to remove the lesion. There were seven patients with clinically insignificant grade 1 arthrofibrosis in each group.[8] Impingement syndrome was not observed in any of the groups.

TABLE I

Assessment of stability, quadriceps circumferences, range of motion and knee function in both groups

	n	Mean±SD	Range	n	Mean±SD	Range	*p*
Preoperative Lachman							
Grade 2	4						
Grade 3	16						
Final follow-up Lachman							
–	13			14			0.5
Grade 1	7			6			
Preoperative pivot shift							
Grade 1	14			3			
Grade 2	6			14			
Grade 3				3			
Final follow-up pivot shift							
–	17			16			0.5
Grade 1	3			4			
Preoperative quadriceps circumference (cm)		2.6	0-5		2.6	1-4	0.65
Postoperative quadriceps circumference (cm)		1	0-2		2.0	1-3.5	
Range of motion (°)		136±4.5			136±43		0.75
Preoperative IKDC score		68.4±3.5	63-76		66.1±3.5	60-73	0.90
Postoperative IKDC score		85.7±2.6	82-90		85.6±2.9	81-91	
Preoperative Lysholm score		75.7±5.2	70-85		73±4.6	67-82	0.94
Postoperative Lysholm score		86.3±4.1	81-96		85.93±7	80-91	

SD: Standard deviation; IKDC: International Knee Documentation Committee.

TABLE II

Tunnel widening in standard and augmentation techniques

	Tibia		Femur	
	Standard	Augmentation	Standard	Augmentation
Postoperative	7.40+0.50	7.50+0.51	7.55+0.51	7.50+0.51
Follow-up	7.90+0.50	7.68+0.52	7.73+0.56	7.58+0.52
Difference in Widening	p=0.001		p=0.03	

There is significantly less widening in the augmentation group in tibial tunnels.

DISCUSSION

We have noted the augmentation technique to be as successful as the standard technique with similar clinical outcomes, cyclops lesion, arthrofibrosis incidence.[6,7,9-15] The main contribution of this study to the literature is examining the effect of augmentation technique on tunnel widening. Although it was hypothesized in a previous study that this technique prevents tunnel widening, the current study is the first to quantitatively analyze this issue.[4] In this study, tunnel widening was found to be significantly less than standard reconstruction.

A shortcoming of this study is measuring the preoperative and postoperative stability by using instability tests, Lachman and pivot shift, instead of arthrometric evaluation. Although arthrometric evaluation provides an objective measure of anterior laxity and has been shown to be both accurate and reliable, The Lachman and pivot shift tests are also adequate to analyze knee stability qualitatively with high sensitivity and specificity although specificity of the pivot shift test is questioned in some studies.[16] Another shortcoming of this study is the use of X ray to measure tunnel width. Researchers have used X ray, computed tomography (CT) and MRI to evaluate tunnel width. Although recent studies advocate use of CT as the most precise method, no validated method has been established.

There are no uniform criteria for the diagnosis of a partial tear of the ACL and there is no certain method for assessing the biological and mechanical extent of tear when a portion of the ACL remains intact. We have arthroscopically investigated the morphological and mechanical fitness of the ACL residual section for application of augmentation technique, instead of distinguishing between partial ACL ruptures as AM or PL tears using the double bundle concept.

Adachi et al.[6] compared 40 patients in which they performed augmentation technique to the AM or PL bundles to a group of patients with standard ACL reconstruction. The ACL augmentation group showed significantly better anteroposterior stability and proprioception than the standard ACL reconstruction group. Siebold and Fu's[3] preliminary results showed good clinical results for AM and PL bundle augmentation at an average of one year postoperatively. The objective and subjective IKDC, Cincinnati Knee Score, and the KT-1000 results increased significantly from preoperatively to follow-up in all patients. Both authors approached the partial ACL tears in double band manner and performed the ACL reconstruction separately as AM or PL bundle augmentation. In their technical note, Ahn et al.[9] stated that they had preserved the remnant ACL and performed augmentation even if it seemed as being attached to the posterior cruciate ligament or like a bridge between the femur and tibia. Although their approach is similar to our study's, they have not published the clinical outcome of their technique.[9]

Tunnel widening, which is a complication of ACL reconstruction surgery, results from biological and biomechanical events. The main reason for the biological events is presence of synovial fluid with elevated concentration of cytokins and inflammatory agents.[17] The fluid is propagated (synovial bathing) through the tunnels, bathing the graft-bone interface with inflammatory enzymes which induce calcitonin to cause widening of the tunnels. Junkin and Johnson[4] hypothesized that remnant ACL prevents the tunnel widening by decreasing leakage of synovial fluid. Similarly, tunnel widening was found to be significantly less in the augmentation group in our study. Synovial bathing can be more prominent on the tibial side, due to gravity. The results of this study support this hypothesis. The augmentation technique was more successful on the tibial side compared to the femoral tunnel, in terms of preventing tunnel widening.

This technique can be performed in cases which were considered partial tears of the ACL by means of physical examination, and MRI prior to the surgical intervention, and definitely diagnosed using arthroscopy, and on those who met criteria described in this study. Because tunnel widening has debilitating

complications, further studies with longer follow-up are necessary to strengthen the clinical advantage of this technique.

Declaration of conflicting interests

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