



## Use of quadriceps tendon versus hamstring tendon autograft for arthroscopic anterior cruciate ligament reconstruction: a comparative analysis of clinical results

Artroskopik ön çapraz bağ onarımı için hamstring tendon otoplastisine kıyasla kuadriseps tendon kullanımı: Klinik sonuçların karşılaştırmalı analizi

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**Objectives:** This study aims to evaluate midterm clinical results of the use of two autogenous graft types.

**Patients and methods:** Between June 2005 and November 2010, clinical data of 44 patients who were operated were retrospectively analyzed. Quadriceps tendon-patellar bone autograft was used for reconstruction surgery in 23 patients (QT-PB group), while quadrupled hamstring tendon autograft was used in 21 patients (HT group). The Tegner's activity scale, Lysholm scoring system, single-leg-hop test and KT-2000 arthrometric measurements were used for data collection.

**Results:** The mean length of follow-up was 37.6 months. Although the mean Lysholm score increased in both groups, excellent results in HT group were two-fold higher compared to QT-PB group. The mean laxity for the operated knee joint was 5.65 mm (3.5 to 8.0 mm) in QT-PB group and 3.67 mm (3.0 to 5.5 mm) in HT group. Head-to-head analysis using KT-2000 arthrometer demonstrated that 12 patients (52.1%) in QT-PB group and two patients (9.6%) in HT group had more than 3 mm of anterior laxity difference.

**Conclusion:** Quadrupled hamstring tendon autograft is superior to central quadriceps tendon-patellar bone in arthroscopic anterior cruciate ligament reconstruction surgery.

**Key words:** Anterior cruciate ligament reconstruction; anterior cruciate ligament; arthroscopy; quadriceps muscle; tendon.

**Amaç:** Bu çalışmada, iki otojen greft türünün kullanımına ilişkin orta dönem klinik sonuçlar değerlendirildi.

**Hastalar ve yöntemler:** Haziran 2005 - Kasım 2010 tarihleri arasında ameliyat edilen 44 hastanın klinik verileri retrospektif olarak incelendi. Onarım cerrahisi için 23 hastada (QT-PB grubu) kuadriseps tendon-patella kemiği otoplastisi, 21 hastada (HT grubu) ise dört katlı hamstring tendon otoplastisi kullanıldı. Veri toplamada Tegner aktivite skalası, Lysholm skorlama sistemi, tek bacak sıçrama testi ve KT-2000 artrometrik ölçümleri kullanıldı.

**Bulgular:** Ortalama takip süresi 37.6 aydı. Ortalama Lysholm skoru her iki grupta da artmasına rağmen, HT grubunda elde edilen mükemmel sonuçlar QT-PB grubundakinin iki katı kadardı. Ortalama laksite miktarı QT-PB grubunda 5.65 mm (3.5-8.0 mm) iken HT grubunda 3.67 mm (3.0-5.5 mm) olarak ölçüldü. KT-2000 artrometre kullanılarak yapılan bire bir analizde QT-PB grubunda 12 hastada (%52.1) ve HT grubunda iki hastada (%9.6) 3 mm'den fazla ön laksite farkı saptandı.

**Sonuç:** Artroskopik ön çapraz bağ onarım cerrahisinde dört katlı hamstring tendon otoplastisi, santral kuadriseps tendon-patella kemiği otoplastisinden üstündür.

**Anahtar sözcükler:** Ön çapraz bağ onarımı; ön çapraz bağ; artroskopi; kuadriseps kasi; tendon.

Knee ligament injuries are among the most frequently encountered injuries.<sup>[1,2]</sup> Although different types of surgical techniques with excellent clinical results have

been reported for the reconstruction of a ruptured anterior cruciate ligament (ACL), graft selection is still a controversial issue. Every particular graft type

has its own advantages and disadvantages discussed in many different clinical research papers.<sup>[3-5]</sup> The purpose of the present study was to comparatively evaluate early clinical results of our patients according to two different autogenous graft types used for arthroscopic ACL reconstruction.

### PATIENTS AND METHODS

Between June 2005 and November 2010, 72 patients underwent ACL reconstruction surgery with use of either autogenous central quadriceps tendon-patellar bone (QT-PB) or quadrupled hamstring tendon (HT) graft in Baltalimanı Bone and Joint Diseases Hospital. Twenty-six patients who had inadequate clinical records and two patients who had had previous surgery were excluded. The clinical data of 44 patients who had attended all the clinical follow-up visits were retrospectively evaluated after obtaining approval from the local ethical research committee and informed consent of each patient. A quadriceps tendon-patellar bone graft was used in 23 patients, and quadrupled hamstring tendon graft in 21 patients. Demographic data of our patients are summarized in Table I. All procedures were primary ligament reconstructions applied for symptomatic chronic ACL deficiency. Mean follow-up time period was 37.6 months (range, 8-70 months).

Tendon grafts used for reconstruction were obtained from ipsilateral quadriceps or hamstring muscles. Using transtibial technique, we created tibial and femoral tunnels. All reconstructions were done as single-bundle ligament reconstructions. We applied a metal interference screw to ensure better fixation at the bony part of the quadriceps tendon graft at the

femoral side, and transfemoral fixation system for the hamstring graft. A bioabsorbable screw was used for tibial side fixation in all patients.

Complaints of pain or anterior knee pain, feeling unsafe in sports activities, any limitations in flexion and extension of the joint were noted. Functional level assessment by the use of Tegner's activity scale and Lysholm knee scoring system were applied preoperatively and also at the latest follow-up visit postoperatively. A single-legged hop test was also included at the latest follow-up. A KT-2000 arthrometer (MEDmetric, San Diego, California) was used to evaluate side-to-side difference in anterior translation between the injured knee and the contralateral, normal knee joint.

Statistical analysis was made by using Wilcoxon signed-rank test to compare related data of preoperative and postoperative periods, Mann-Whitney U test to compare independent interval data, and chi-square test. The level of significance was set at  $p \leq 0.05$ .

### RESULTS

Eight (18.1%) of 44 patients had complained of intermittent pain. Anterior knee pain was diagnosed in five of the 23 patients who had reconstruction with QT-PB graft. The other three patients were from the HT group, and the reason for pain was determined as inadequate rehabilitation of the balance of muscle strengths around the knee joint. At the latest follow-up, five patients (21.7%) from QT-PB group emphasized different degrees of instability and feeling unsafe in sports activities, whereas none of the patients from the HT group had any such complaint. The range of motion

**TABLE I**  
Demographic data of the groups

	QT-PB group			HT group		
	n	%	Mean	n	%	Mean
Mean age at the time of surgery (years)			26.8			28.6
Gender						
Male	21			21		
Female	2			0		
Side						
Left	8			10		
Right	15			11		
Etiology (sports injury)		86.9			90.4	
Time from injury to surgery (months)	18.5			13.4		
Accompanying knee injury	9			11		

QT-PB: Quadriceps tendon-patellar bone; HT: Hamstring tendon.

**TABLE II**  
Lysholm scores of the patients

Lysholm score	Preoperative				On latest follow-up			
	QT-PB group		HT group		QT-PB group		HT group	
	n	%	n	%	n	%	n	%
<64 (poor)	22	95.6	19	90.5	1	4.3	0	0
65-83 (fair)	1	4.4	2	9.5	2	8.7	0	0
84-94 (good)	0	0	0	0	14	60.8	9	42.8
95-100 (excellent)	0	0	0	0	6	26.2	12	57.2

QT-PB: Quadriceps tendon-patellar bone; HT: Hamstring tendon.

measurements at the time of the latest follow-up did not reveal any difference according to graft choice.

According to the Tegner scale, activity level was significantly increased in both groups similarly at the latest follow-up in comparison to preoperative status. Tegner scale changes between preoperative period and latest follow-up were similar for both groups. The mean Lysholm score improved in both groups, but excellent results in the HT group were twice the number of excellent results in the QT-PB group (Table II). The single-legged hop test at latest follow-up demonstrated that 10 patients (43.5%) in the QT-PB group and 16 patients (76.2%) in the HT group could achieve more than 90% performance.

KT-2000 arthrometric analysis was applied to operated knee joints of the patients, as well as the healthy sides. The mean anterior laxity of the healthy joint was 2.86 mm (1.5 to 4 mm) in the HT group and 2.5 mm (1 to 4 mm) in the QT-PB group. On latest follow-up, according to instrumented laxity measurement of the operated knee joint, mean laxity was 5.65 mm (3.5 to 8.0 mm) in the QT-PB group and 3.67 mm (3.0 to 5.5 mm) in the HT group (Table III). This difference was found to be statistically significant ( $p < 0.001$ ). Side-to-side analysis using the KT-2000 arthrometer demonstrated that twelve patients (52.1%) from the QT-PB group had more than 3 mm of anterior laxity difference; however it was only two patients (9.6%) in the HT group ( $p < 0.001$ ).

## DISCUSSION

Although it is one of the autogenous graft options studied and discussed in scientific levels, the QT-PB graft is less popular than the HT graft. It is generally preferred in revision surgery or in patients with multiple ligament injuries. A central quadriceps tendon autograft, applied with or without patellar bone plug, was shown to be a reasonable option for ACL reconstruction surgery from the biomechanical point of view.<sup>[6]</sup> As far as we could determine, we did not find any literature comparing the clinical results of these two different autografts.

Recent soft-tissue fixation methods demonstrate substantially improved biomechanical properties that allow more aggressive rehabilitation following ACL reconstruction.<sup>[7]</sup> Poolman et al.<sup>[8]</sup> reported that newer hamstring graft fixation methods yielded similar stability as bone-patellar tendon-bone grafts. None of our patients had any clinical problem requiring revision surgery due to failure of fixation.

Anterior knee pain is the major morbidity associated with the harvest of the grafts including patellar bone. Geib et al.<sup>[9]</sup> reported that donor site morbidity following quadriceps tendon autograft harvesting is less than that of patellar tendon graft. Anterior knee pain and kneeling pain have been shown to be lower in hamstring autograft patients.<sup>[10,11]</sup> In our study, eight of 44 patients (18.1%) complained of intermittent pain. Anterior knee pain originating

**TABLE III**  
KT-2000 arthrometric measurements on latest follow-up

Group	Group QT-PB		Group HT	
	Mean	Range	Mean	Range
Operated knee joint laxity (mm)	5.65	3.5-8.0	3.67	3.0-5.5
Healthy knee joint laxity (mm)	2.86	1.5-4.0	2.5	2.0-4.0

QT-PB: Quadriceps tendon-patellar bone; HT: Hamstring tendon.

from the patellofemoral joint was diagnosed in five patients from the QT-PB group. The other three patients were from the HT group, and the reason of pain was determined as inadequate rehabilitation of the balance of muscle strengths around the knee joint. None of the patients from the HT group had patellofemoral joint problems.

Atik reported that reconstruction of the anterior cruciate ligament was not a prerequisite for restoring muscle function.<sup>[12]</sup> Research showed that ACL reconstruction using hamstring tendons preserves the extensor mechanism and prevents quadriceps atrophy.<sup>[13]</sup> A prospective, randomized study comparing patellar tendon and hamstring autografts for ACL reconstruction demonstrated that significantly more patients in the patellar tendon group had extension loss (52% vs. 27%).<sup>[14]</sup> Minor loss of extension was reported as much more common in patellar tendon graft patients than in hamstring graft.<sup>[15]</sup> Dolai et al.<sup>[16]</sup> reported that extension loss following ACL reconstruction with BPTB was seen in 15.2% of their patients. In our patients, range of motion measurements at the latest follow-up did not reveal any difference according to graft choice, or any flexion-extension deficit in comparison to preoperative status. A single-legged hop test on latest follow-up demonstrated that 10 patients (43.5%) in the QT-PB group and 16 patients (76.2%) in the HT group could achieve more than 90% performance. We believe that the QT-PB graft leads to extensor weakness more than the HT graft.

Functional scoring systems are used to evaluate subjective results. We applied Tegner activity scale and Lysholm scores to compare preoperative and latest follow-up functional levels. A KT-2000 arthrometer was used for objective instability analysis of operated knee joints of our patients, as well as healthy knee joints for side-to-side comparison. Kim et al.<sup>[17]</sup> reported that the postoperative mean side-to-side difference for single bundle quadriceps reconstruction in 28 patients was 2.64 mm. According to Geib et al.,<sup>[9]</sup> when compared with BPTB autograft, the quadriceps tendon autograft showed significantly higher percentage of arthrometer measurements showing a side-to-side difference less than 3 mm in 88% of the patients. Another study showed that following ACL reconstruction with a central quadriceps tendon autograft, 68% of 240 patients had less than 3 mm anteroposterior laxity.<sup>[18]</sup> Shaieb et al.<sup>[14]</sup> performed a prospective randomized study of patellar tendon versus hamstring autografts for ACL reconstruction. They found no significant differences between the

groups for Lysholm score, return to sports, reduction in activity, KT-1000 arthrometer findings, or patient assessed outcomes. Pinczewski et al.<sup>[19]</sup> compared patellar tendon and quadrupled hamstring tendon autografts for ACL reconstruction and no significant laxity difference was noted between the groups in the five-year results. In a prospective, randomized study comparing patellar and hamstring tendon autografts for ACL reconstruction, Jansson et al.<sup>[20]</sup> found no difference at the end of two years postoperatively. In our study, when we compare the results of KT-2000 arthrometric measurements of the operated knee joints on latest follow-up, the quadrupled hamstring tendon graft was found to be significantly more stable than the quadriceps tendon-patellar bone autograft. Side-to-side analysis has also shown that 47.9% of the patients from the QT-PB group had less than 3 mm of anteroposterior laxity difference with respect to the non-operated knee joint, whereas it was 90.4% in the HT group ( $p < 0.001$ ). Our findings of instrumented laxity measurement in the QT-PB group are controversial compared to the literature. We believe that when a central quadriceps tendon autograft with patellar bone plug is harvested for ACL reconstruction, the quadriceps tendon diameter and strength are decreased greatly, and these changes lead to increased biomechanical stress on the reconstructed ligament in the early stages of healing. This increased biomechanical stress in the early stages may cause earlier elongation of the reconstructed ligament, explaining why our findings of instrumented laxity measurement in the QT-PB group were worse than in the HT group.

Relatively small patient groups and short follow-up periods may be the limitations of the present study. We included only patients who attended all of the routine postoperative outpatient clinic visits and were reached for the latest follow-up. That is why the group sizes diminished, but at the same time, it gave us the chance to have more valuable and comparable homogenous data.

In conclusion, according to our data that we acquired at the end of this study, a quadrupled hamstring tendon autograft is superior to a central quadriceps tendon-patellar bone graft, and we believe that quadrupled hamstring tendon should be the preferred choice of autograft for the surgical treatment of patients with chronic ACL deficiency.

#### **Declaration of conflicting interests**

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