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The Results Of Reconstruction Of The Anterior Cruciate Ligament Using The "Endobutton CL" System And Four-Strand Hamstring Tendon Autografts

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ABSTRACT

Objective: The aim of the study was to evaluate the results of anterior cruciate ligament (ACL) reconstruction using a hamstring tendon autograft.
Material and Method: The study included 74 male, 2 female patients (mean age 26,7 years; range 17 to 43 years) with chronic ACL ruptures. Involvement was in the right knee in 39 patients, and in the left knee in 37 patients. All the patients were treated with a four-strand hamstring autograft, Endobutton CL femoral fixation and an interference screw on the tibial side. All patients had an ACL reconstruction with an autogenous four-strand hamstring graft. Forty-one patients received treatment for other meniscal pathologies. All patients followed a similar accelerated rehabilitation program after surgery. Final evaluations were made using the Lysholm and International Knee Documentation Committee (IKDC) scoring systems, Cincinati and the Tegner activity rating system in the final follow-up.
Results: The Lysholm scores were good and excellent for 67 patients (88,2 %) and the IKDC scores were grade A or B in 68 patients (89,4 %) and grade C in 8 patients (10,5 %). Radiographic examination showed mild (three patients) or moderate (two patients) degenerative changes in the knee joint. Compared with the normal side, no flexion or extension losses occurred in the affected knees.
Conclusion: Reconstruction of the ACL using four-strand hamstring tendons and Endobutton CL femoral fixation may be a safe and effective method, resulting in considerably high success rates.

Key Words: *Anterior cruciate ligament, Arthroscopy, Reconstructive surgery, Endobutton CL.*

ÖZET

Ön Çapraz Bağ Yırtığının "Endobutton CL" Sistemi ve Dört Katlı Hamstring Tendon Otogrefti ile Rekonstrüsiyonunun Sonuçları

Amaç: Hamstring tendon otogrefti kullanılarak ön çapraz bağ (ÖÇB) rekonstrüksiyonu yapılan hastaların sonuçları değerlendirildi.
Gereç ve Yöntem: Çalışmaya kronik ÖÇB yırtığı olan 74 erkek, 2 bayan hasta (ort. yaş 26,7; dağılım 17-43) alındı. Otuz dokuz hastada sağ dizde, 37 hastada sol dizde lezyon vardı. Tüm hastalar artroskopik olarak dört katlı otogreft hamstring tendonu, proksimal tespit Endobutton CL sistemi ve tibial tarafta interferans vidası ile tedavi edildi. Kırk bir hastanın, cerrahi sırasında tespit edilen menisküs problemlerine parsiyel menisektomi uygulandı. Bütün hastalara postoperatif dönemde benzer hızlandırılmış iyileştirme programları uygulandı. Hastalar ameliyat öncesi ve sonrası Lysholm, International Knee Documentation Committee (IKDC) skorlama, Cincinati ve Tegner aktivite derecelendirme sistemleri ile takip edildiler.
Bulgular: Lysholm skorlamasında 67 hasta (% 88,2) iyi ve mükemmel sonuç, IKDC skorlamasına göre 68 hasta (% 89,4) A veya B, 8 hasta (% 10,5) ise C olarak değerlendirildi. Radyografik değerlendirmede, üç hastanın diz ekleminde hafif, iki hastada orta derecede dejeneratif değişiklikler gözlendi. Sağlam tarafla karşılaştırıldığında, hastalarda fleksiyon ve ekstansiyon kaybı gözlenmedi.
Sonuç: ÖÇB rekonstrüksiyonunda dörtlü hamstring tendonu ve Endobutton CL sistemi ile yapılanlan cerrahi tedavinin güvenli ve orta dönem sonuçlarının başarılı olduğu görüşüne varılmıştır.

Anahtar Kelimeler: *Ön çapraz bağ, Artroskopi, Rekonstrüktif cerrahi, Endobutton CL.*

In orthopedics, one of the focuses of current research is surgery on the anterior cruciate ligament (ACL) (1). The aim of surgery is to restore the ACL function, to maintain the proprioceptive mechanisms lost as a result of injury, thus reducing the risk of osteoarthritis (2).

Number of patients undergoing ACL reconstruction has risen and more favorable results have been obtained with the advances in arthroscopic surgery and developments in ACL reconstruction equipment. A number of graft types have been developed in line with the developments in surgical equipment (3, 4). Recently, the hamstring tendon has become the preferred autogenous graft (5-7).

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In this study, we aimed to evaluate the mid-term clinical outcomes of ACL reconstruction using a Endobutton CL femoral fixation system and four-strand hamstring autografts.

MATERIAL AND METHOD

Patients and healthy volunteers were included in the study after giving written informed consent, and the study was approved by the institutional ethics committee. The study was run in accordance with the ethical principles for human investigations, as out lined by the Second Declaration of Helsinki.

Between 2008 and 2010, hamstring autografts were used in 76 patients (74 men and 2 women; mean age: 26.7, range: 17-43 years) for the reconstruction of ACL ruptures. Diagnosis was based primarily on anamnesis and physical examination. The patients were administered with anterior drawer, Lachman and pivot shift tests. Diagnosis was confirmed by using MRI. Approximately 85.5 % of accidents occurred while the subjects were playing football or as a result of falls. Patients with osteoarthritis (OA) at the time of surgery and those with multi-ligaments injury were excluded.

Patients were examined by the same two individuals with the anterior drawer, Lachman and pivot shift tests. Lysholm, IKDC scoring, Cincinati and Tegner activity rating systems were used in the preoperative and final clinical evaluations.

The results of these operations were investigated in this prospective non-randomized clinical study. In the overall series, the mean time lapse before operation was 25.3 (range: 2-72) months. While 39 (51,7 %) patients had right knee lesions, the remaining 37 patients (48,3 %) had lesions in the left knee. There was an accompanying tear in the medial meniscus in 27 patients, the lateral meniscus in 8 and the bilateral meniscus in six. These patients underwent partial meniscectomy during the ACL reconstruction.

Surgery

Gracilis and semitendinosus tendons were harvested using a tendon stripper. The knee joint was then arthroscopically evaluated through standard arthroscopy portals. Femoral tunnels were opened at the 10 or 2 o'clock positions through a medial portal with a convenient width to accommodate gracilis and semitendinosus tendons folded 4 times. Tibial tunnels were laid at 55 degrees to the ACL stump through graft incision. Prepared grafts were embedded intra-articularly through the tibial tunnel and fixed using an Endobutton CL (Smith & Nephew Inc., Andover, MA, USA) at the femoral site and a bioabsorbable screw and a U nail at the tibial site. The mean time of surgery in our series was 80 minutes (range: 60 – 120 minutes).

Postoperative rehabilitation

Angle-adjustable long knee braces were used for the first three weeks postoperatively to ensure a controlled mobilization. Partial weight-bearing was allowed for the first three weeks for balance purposes only. Flexion was started at 80 degrees and increased by 10 degrees weekly, for 6 weeks. An unlimited range of knee motion was allowed at week 6. At the end of the third month jogging was allowed and non-competitive sports at the sixth month. At month 9 all activity restrictions were lifted. At the last follow-up, knee proprioception was measured against the healthy side. In addition, circumference measurements made in 15 cm proximal to superior pole of the patella were also evaluated.

RESULTS

Mean follow-up time was 25.6 (range: 15-37) months. Preoperative Lysholm scores rose from a mean of 64.3 (range: 38-86) to a mean of 93.2 (range: 70-100) in the final control. According to the Lysholm scoring, 67 patients % (88.2) had perfect or good results (Table 1). According to the IKDC knee ligaments standard evaluation system, it was found that 2 cases (2.6 %) were in Group B, 26 cases (34.2 %) were in Group C and 48 cases (63.2 %) were in Group D preoperatively. In the postoperative examination, 41 cases (53.9 %) were included in Group A, 27 (35.5 %) in Group B, and 8 (10.5 %) in Group C (Table 2). While the mean Tegner activity score was 3.5 (range: 1-7) preoperatively, it was found to be 5.2 (range: 3-9) in the postoperative late follow-up examinations (Table 3). At the final follow-up, 71 (93.4 %) patients had no degenerative change in any compartments of the knee joint. Three patients had mild degenerative change, and two patient had moderate degenerative change in all compartments of the knee joint. According to the Cincinati scoring, 72 patients % (94.7) had perfect or good results postoperatively (Table 4).

***Table 1**. Preoperative and postoperative Lysholm scoring results*

Lysholm score	Pre-op	Post-op
95-100	-	56 (% 73,7)
84-94	1 (% 1,3)	11 (% 14,5)
65-83	38 (% 50)	9 (% 11,8)
0-64	37 (% 48,7)	-
Mean	64,3	93,2

***Table 2**. Preoperative and postoperative IKDC scoring results*

IKDC	Pre-op		Post-op	
A	-	-	41	% 53,9
B	2	% 2,6	27	% 35,5
C	26	% 34,2	8	% 10,5
D	48	% 63,2	-	-

In the examination of ligamentous stability using the Lachman test we were able to verify normal anteroposterior laxity in 61 patients (80.3 %) while eight patients had 1+, six patients had 2+, and one patient had 3+ Lachman test scores. In the results of the pivot-shift test; 63 patients (82.9 %) had normal scores. Nine patients had 1+ pivot glide and four patients had 2+ pivot-shift. No patients had a grossly positive pivot-shift test result. At 1 year postoperatively, light to moderate crepitation was identified in the patellofemoral joint in 6 (7.9 %) patients. But patellofemoral pain was not reported by our patients.

***Table 3**. Preoperative and postoperative Tegner scoring results*

Tegner score	Pre-op		Post-op	
1	1	% 1,3	-	-
2	17	% 22,4	-	-
3	24	% 31,6	11	% 14,5
4	19	% 25	21	% 27,6
5	7	% 9,2	15	% 19,7
6	5	% 6,6	17	% 22,4
7	3	% 3,9	5	% 6,6
8	-	-	2	% 2,6
9	-	-	5	% 6,6
10	-	-	-	-
Mean	3,53		5,13	

***Table 4.** Preoperative and postoperative Cincinnati scoring results*

Cincinnati score	Pre-op	Post-op	Result
26-30	1 (% 1,3)	63 (% 82,9)	Perfect
21-25	33 (% 43,4)	9 (% 11,8)	Good
16-20	19 (% 25)	4 (% 5,3)	Fair
15 ↓	23 (% 30,3)	-	Poor

One-legged hop test was performed as a functional test for patients. Sixy- eight (89.5 %) patients passed this with results between 80% and 100%. In measurements made 15 cm proximal to the superior pole of the patella, the decrease in the circumference was 1 cm in 31 patients, 2 cm in 13 and 3 cm in 5 preoperatively. In the postoperative final control, the circumference decrease was 3 cm in 5 patients, 2 cm in 11 and 1 cm in 9. Quadriceps exercises were re-started in patients with 3 cm decrease in circumference. No patients had any neurovascular problems in the knee joint region. No arthrofibrosis or adhesions developed. No knee joint punction of the operated knee due to significant joint effusion was required. Five patients exhibited only minimal or moderate joint effusion. Septic arthritis was diagnosed in one patient. He was treated arthroscopically by joint irrigation and was administered a 6-week course of intravenous antimicrobial therapy. In this patient, removal of the interference nails was not necessary therefore his results were not excluded from the study.

DISCUSSION

ACL reconstruction is one of the most operations in orthopedic surgery. However, bone-patellar tendon-bone complex, hamstring tendon autografts, and allografts are commonly used as the graft sources, which graft is the most suitable has still been controversial (7-10).

Synthetic grafts are almost never used because of the poor results reported by Chang et al. (11). Allografts are primarily preferred by some surgeons because the grafts are easy to obtain in the desired sizes and have low perioperative morbidity, shorter operative time and less motion restriction in the postoperative period. However, the main disadvantages of reconstruction with allografts include disease transport, immunogenic rejection of the graft, resorption in the tunnel, long remodeling period and high cost (12, 13).

Donor site morbidity has been reported following the application of autologous patellar tendon grafts including kneeling pain, tendon shortening, patellar chondromalacia, patellar fractures, patellar tendon ruptures, patellofemoral pain syndromes and persistent quadriceps weakness (8, 14-17).

Hamstring tendons are biomechanically superior to the patellar tendon (18, 19). Isometry of the anterolateral and posteromedial parts of the normal anterior cruciate ligament varies depending on the degree of knee flexion. Due to the four-strand structure, hamstring tendon grafts mimic this characteristic of the anterior cruciate ligament most closely (20). The use of quadruple hamstring grafts is not recommended in overweight patients (more than 100 kg), sprinters and patients with medial laxity or with a pivot shift test result of 4 (+), which constitutes the limitations of quadruple hamstring grafts (21, 22).

Different methods are currently used in fixation with hamstring grafts. The most common include screws, EndoButtons and cross-pins. In a study conducted on graft fixation materials, Brand et al. (23) Stated that while cross-pins were not weaker than EndoButtons or other fixation methods in terms of force and loading, however, the disadvantages were reported to be the need for an additional incision and the occurrence of dilatation due to in-depth fixation in the tunnel.

A range of methods and materials are used to fix the hamstring tendon in ACL reconstruction. Endobutton post-fixation (Smith & Nephew Inc., Andover, MA, USA) is one of the most common techniques used to fix the autograft in the lateral femoral cortex. In biomechanical studies, graft stiffness was reported to be 61±11 N/mm (24).

In a prospective study of 29 patients who had undergone ACL reconstruction with an autogenous hamstring graft, Price et al. compared EndoButton

versus transfix femoral fixation. No clinically significant difference was found; however, they reported that complications and additional procedures postoperatively occurred more frequently in the cross-pin group (25).

Several theories have been developed to account for tunnel widening following ACL reconstruction, including mechanical and biological contributions. Within the tunnel, up and down motion (a bungee effect) and side to side motion (the motion of windshield wipers) can occur. Extravasation of synovial fluid that contains various cytokines into the tunnel around the graft may be increased by this motion and this interferes with the soft tissue-to-bone healing (26). In the suspensory fixation system, these interactions are likely to occur.

Fauno and Kaalund (27) reported that tunnel widening is influenced by the mechanical properties of the implants and more patients with increased knee laxity were in the extracortical fixation (Endobutton fixation) group compared to the close-to-joint fixation (Transfix) group. However, the clinical results were considered successful in both groups.

Kong et al. (28) reported that no difference in the femoral and tibial tunnel widening, there were no statistical differences in the functional outcomes, such as the IKDC classification and the KT-2000 arthrometer side to side difference between the 2 femoral fixation systems and the clinical results were considered successful in both groups.

Hame et al. (30) investigated the efficacy of notchplasty and reported that a certain amount of notchplasty, even if very limited, was required to provide the most suitable placement in the tunnel. Similarly, Horner et al. (30) stressed the importance of notchplasty in preventing graft jamming and providing favorable tunnel placement. Tafler underlined that notchplasty had to be performed until posterior border of the notch could be seen. Tafler also pointed out that if graft jamming occurred in the roof of the notch after the placement of the graft, that part had to be removed shaved as well. All our patients underwent notchplasty in this present study. In narrow notches, lateral wall of the notch has to be removed shaved as well, to prevent graft jamming. As Hame et al. (30) emphasized, an unexaggerated amount of notchplasty is essential in preventing early loosening (12, 29-31).

Authors such as Howell (32) and Beynnon (33) do not have their patients use a brace following ACL reconstruction. We used angle-adjustable hinged knee braces in the postoperative period. Those not only ensure controlled movement, but also protect the graft by reducing the load on the graft until adequate quadriceps strength is achieved (34). The principal aim is to obtain full quadriceps strength and good range of motion by the 3rd or 4th week. We continued the rehabilitation with straight leg raising exercises and kept the brace during 3 to 6 weeks until a motion in range of 0-120° was obtained. After the removal of the drain, we mobilized our patients and allowed weight bearing as much as tolerated. While early full weight bearing may lead to hemarthrosis which can impair rehabilitation, it should not be delayed more than 3 weeks (34, 35). This rehabilitation enabled all patients to return to contact sports within 6 months.

A positive pivot-shift phenomenon was observed in 14 patients and there were 3 + Lachman test scores in one patient. These results are parallel to those reported by Aglietti et al. (36) Eriksson et al. (37) observed manual laxity (according to the Lachman test) after treatment using the semitendinosus tendon. The same laxity was observed in our patients. Aglietti et al. (36) reported a slight loss of extension in 3 % of patients in their hamstring group.

Endobutton femoral fixation showed good results in hamstring ACL reconstruction. Tunnel widening following reconstruction developed and this did not lead to failure of surgery. We conclude that Endobutton CL are useful materials for femoral tunnel fixation in hamstring ACL reconstruction surgery.

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