

## Comparison of the open primary repair with augmentation and without augmentation in acute achilles tendon rupture

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**Aim:** To compare the clinical and the functional efficiency of 2 surgical methods that are used in open primary repair of acute Achilles tendon ruptures: one that utilizes the augmentation of the plantaris tendon and one that does not.

**Materials and methods:** Data were evaluated from 41 patients that underwent surgical repair for acute Achilles tendon ruptures with these 2 different surgery methods. In the first group, which included 21 patients (19 male, 2 female; mean age: 36.8 years; age range: 22 to 49), we performed augmentation with the plantaris tendon after an end-to-end primary repair with a modified Kessler technique. In the second group, which included 20 patients (19 male, 1 female; mean age: 41.4 years; age range: 23 to 52), we did not perform augmentation after the end-to-end primary repair with a modified Kessler technique. For both groups, we used polydioxanone suture (PDS) materials in Kessler knots.

**Results:** The mean American Orthopedic Foot and Ankle Society (AOFAS) hindfoot clinical outcome score was  $94 \pm 6.4$  (range: 73-100) in the first group. In the second group, the mean AOFAS score was  $94.4 \pm 6.1$  (range: 76-100). The first group's mean Achilles tendon assessment score was  $81.7 \pm 10.9$  (good, range of 60-96); the mean Achilles tendon assessment score of the second group was  $82.4 \pm 6.1$  (good, range of 71 to 94). There was no statistically significant difference between these 2 groups in terms of functional scores ( $P > 0.05$ ). In the first group, 2 patients (9.5%) had superficial skin infections and 1 patient (4.7%) had hypertrophic scar tissue. In the second group, 3 patients (15%) had superficial skin infections and 1 patient (5%) experienced a partial rerupture.

**Conclusion:** Clinical and functional results did not show any statistically significant difference between methods with or without augmentation when appropriate and progressive rehabilitation programs were applied in treating acute Achilles tendon ruptures.

**Key words:** Achilles tendon, injuries, augmentation, surgery

### Akut aşil tendonu yırtıklarında güçlendirmeli ve güçlendirmesiz açık primer tamirin karşılaştırılması

**Amaç:** Akut aşil tendon yırtıklarının açık primer tamirinde plantaris tendonuyla güçlendirme yapılan ve yapılmayan 2 farklı cerrahi metodun fonksiyonel ve klinik açıdan etkinliğinin karşılaştırılması.

**Yöntem ve gereç:** Akut aşil tendon yırtığı nedeniyle 2 farklı cerrahi yöntem uygulanan 41 hastanın verileri değerlendirildi. Birinci gruptaki 21 hastaya (19 erkek, 2 kadın; ortalama yaş 36,8; dağılım 22-49) modifiye Kessler tekniği kullanılarak uç-uca tamir yapıldıktan sonra plantaris tendonuyla güçlendirme uygulandı. İkinci grupta ise 20 hastaya (19 erkek, 1 kadın; ortalama yaş 41,4; dağılım 23-52) herhangi bir takviye uygulanmadan modifiye Kessler tekniği kullanılarak primer uç-uca tamir yapıldı. Her 2 grupta Kessler düğümlerinde PDS (polidioksanon) dikiş materyali kullanıldı.

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**Bulgular:** AOFAS skoru (The American Orthopaedic Foot and Ankle Society hindfoot clinical outcome scores) birinci grupta ortalama  $94 \pm 6,4$  (dağılım 73-100), ikinci grupta ise ortalama  $94,7 \pm 6,1$  (dağılım 76-100) olarak hesaplandı. Aşil tendon değerlendirme skoru birinci grupta ortalama  $81,7 \pm 10,9$  (iyi, dağılım 60-96), ikinci grupta ortalama  $82,4 \pm 6,1$  (iyi, dağılım 71-94) olarak bulundu. Gruplar arasında fonksiyonel skorlar açısından fark saptanmadı ( $P > 0,05$ ). Birinci grupta 2 hastada (% 9,5) yüzeysel enfeksiyon, 1 hastada (% 4,7) ise hipertrofik skar dokusu gelişti. İkinci grupta ise 3 hastada (% 15) yüzeysel cilt enfeksiyonu ve 1 hastada (% 5) parsiyel rerüptür gelişti.

**Sonuç:** Çalışmamızda akut aşil tendon yırtıklarında güçlendirme yapılan ve yapılmayan primer tamirlerde; uygun ve aşamalı rehabilitasyon programı uygulandığında fonksiyonel ve klinik açıdan istatistiksel olarak anlamlı bir fark olmadığı gösterilmiştir.

**Anahtar sözcükler:** Aşil tendonu, yaralanma, güçlendirme, cerrahi

## Introduction

The Achilles tendon is made up of the association of the gastrocnemius and the soleus tendons. It is usually ruptured 2-6 cm proximal to the calcaneal adhesion point (1). The most commonly seen rupture mechanism is when a foot in plantar flexion turns to dorsiflexion. The patients are mostly male patients, 30-40 years old, who resume athletics after having taken a break (2,3). With the increase in the number of people who engage in sporting activities, the frequency of Achilles tendon ruptures has also shown an increase (4,5).

Treatment for Achilles tendon ruptures is still a matter of discussion. Open surgery, percutaneous surgery, and conservative methods are among the treatment methods. The aim of these 3 methods is to enable the patient to return to his daily and sports activities by helping the tendon to regain its former anatomic length, tonicity, and force.

Open treatment is the most preferred treatment method because it permits the restoration of anatomic of tendon length, engenders a minimum loss of force, and allows for a shorter cast assessment, thereby limiting the related calf atrophy and joint movement limitation (6,7). For all of these reasons, there is a consensus that open surgery is the best initial treatment option for patients who are engaged in active sports (6-8). Different treatment methods for the open surgery treatment are explained in this paper. One of the most widely used methods is the primary end-to-end treatment; treatment with augmentation of different tendons and fascias is another popular option (9-12).

In this study, we compared the clinical and the functional efficiency of 2 methods that are used in the open primary repair of acute Achilles tendon ruptures: one that utilizes the augmentation of the plantaris tendon and one that does not.

## Materials and methods

The present study, performed between February 2003 and May 2007, examined a total of 41 patients (38 men, 3 women; mean age: 39 years; age range: 22-52), on whom primary repair was performed due to acute Achilles tendon rupture. The ruptures of 24 patients (58.5%) were found on the right side; ruptures were on the left side for the remaining 17 (41.4%). The dominant side was ruptured in 25 (61%) patients. The ruptures were caused by participation in active sports for 25 (61%) patients, by walking for 8 (19.5%) patients, by falling or sprain injury for 6 (14.6%) patients, by traffic accident for 1 (2.4%) patient, and as a result of self-mutilation by 1 (2.4%) patient. No report of steroid use was found in any of the patient histories (Table 1).

The majority of the patients (32 out of 41) were admitted to our emergency service and the remaining 9 visited our polyclinic soon after sustaining the initial injury; all received a diagnosis of Achilles tendon rupture. Diagnoses were made according to patients' stories and physical examination. The most important complaint that brought them to the hospital was the pain and rupture that they felt behind their ankle. During the physical examination, they were inspected according to the presence of a gap (defective), swelling, and ecchymosis, and the Thompson test and the movement of the ankle. The

Table 1. Comparison of the features of patients with Achilles tendon ruptures.

	Group 1		Group 2	
	n	%	n	%
Number of patients	21	51.2	20	48.7
Gender				
Male	19	90.4	19	95
Female	2	9.5	1	5
Injured side				
Right	13	61.9	11	55
Left	8	38	9	45
Dominant side				
Right	20	95.2	15	75
Left				
Dominant side injured	14	66.6	11	55
Occupational demands				
Sedentary profession	5	23.8	6	30
Mild workload	12	57.1	9	45
Heavy workload	4	19	5	25
Athletic activity				
No sports	6	28.5	8	40
Occasional/irregular sports	8	38	7	35
More than once a week/regularly	7	33.3	5	25
Injury mechanism				
Sports	15	71.4	10	50
Walking (nonathletic)	3	14.2	5	25
Falling, flexion (nonathletic)	3	14.2	3	15
Other (incisive, traffic accident, etc.)	-	-	2	10

diagnosis and level of the rupture were verified with ultrasonography (USG), and magnetic resonance imaging (MRI) was used on patients when needed.

The patients who were diagnosed with Achilles tendon rupture were operated on using 1 of the 2 different surgical methods within 48 h of the event. After end-to-end treatment of the first group, which included 21 patients (19 men, 2 women; mean age: 36.8 years; age range: 22-49 years), augmentation with the plantaris tendon was performed. In the second group, which included 20 patients (19 men, 1 woman; mean age: 41.4 years; age range: 23-52 years), end-to-end repair was completed without any additional augmentation.

### Surgical technique

Spinal anesthesia was administered to 26 patients and general anesthesia to 15 patients. The patients were asked to lie down in a prone position after a tourniquet was applied to the affected side. In both groups, a posteromedial longitudinal incision was used in order to reach the rupture. Care of the healthy tendon sheath was taken and unnecessary resection was avoided as much as possible. The ends of the ruptured tendon were cleaned of necrotic and dead tissues. The plantaris tendon of the patients in the first group was found and freed. In both groups, end-to-end fixing was performed with a modified Kessler method by using 1 PDS suture while the

ankle was 20° in plantar flexion and the knee was 15° in flexion. For patients in the first group, the freed plantaris tendon was first passed through the tendon from the proximal part of the rupture, then from the distal part. Afterwards, it was widened like a membrane and the rupture was stitched with Vicryl (size 4), as described by Lynn (12). In both groups, we used a long leg cast while the ankle was 20° in plantar flexion and the knee was 15° in flexion.

### Postoperative care

The patients were not allowed to stand up on the first day after the operation in order to prevent edema. On the second day after the operation, they were allowed to walk with the help of crutches and were discharged from the hospital after being educated about isometric exercises. All patients were recommended prophylactic low-molecular-weight heparin therapy for 4 weeks. In the fourth week, the cast was removed and then an angle-adjusted ankle orthosis was applied for 4 more weeks. Meanwhile, range of motion (ROM) exercises were gradually applied to the ankle. During the sixth week, patients were allowed to walk putting their full weight on the injury, and in the eighth week, the orthosis was removed completely. After the orthosis was removed, the ankle exercises were continued for an additional month with the help of a physiotherapist.

In order to compare the effectiveness of the treatments, 2 different scoring systems containing objective and subjective measurements were used. These were the American Orthopedic Foot and Ankle Society (AOFAS) hindfoot clinical outcome score (13), which makes up the subjective measurement, and the Achilles tendon evaluation score, which constitutes the objective measurement and was described by Thermann et al. (14,15). In the AOFAS scoring, patient perception of pain constitutes 40 points, while function and permutation account for 50 and 10 points, respectively. Each patient's score is given out of a total of 100 points. While this evaluation method offers information on the subjective parameters that reflect patient satisfaction, the objective parameters are based on measurements taken in comparison with the tendon in the patient's healthy leg. Among these measurements are: ankle plantar flexion and dorsiflexion opening by using goniometer, calf muscle wideness, the Thompson

test, upward movement of the toe of one foot, and plantar flexion strength as measured by a mechanic dynamometer. If the final score is between 90 and 100, the result is considered to be very good; between 80 and 89 is good; between 70 and 79 is a "middle" score; and a final evaluation between 60 and 69 indicates a bad functional result. These scorings were repeated after the first and second years and our study aimed to determine whether or not there was an important difference. Apart from these scores, postoperative complications were researched in both the short and long term.

### Results

The mean operation time was 75 min (range: 65-90 min) for the first group and 50 minutes (range: 40-60 min) for the second group. The mean follow-up time was 40.8 months (range: 22-73 months). The mean AOFAS score of the 21 patients in the first group was  $94 \pm 6.4$  (range: 73-100); the mean score of the 20 patients in the second group was  $94.4 \pm 6.1$  (range: 76-100). According to the Mann-Whitney U test, no statistically significant difference was found between the 2 groups ( $P > 0.05$ ). In both groups, the mean results were satisfactory. According to the Achilles tendon scoring, while the first group's mean score was  $81.7 \pm 10.9$  (good, range of 60-96), the second group's mean score was  $82.4 \pm 6.1$  (good, range of 71-94). Again, no statistically significant differences were seen between these values according to the Mann-Whitney U test ( $P > 0.05$ ). A dorsiflexion loss of more than 10° was seen in 2 (9.5%) patients from the first group and 1 (5%) patient from the second group. In each group, 2 patients (9.5%-10%) experienced calf muscle atrophy of more than 2 cm. The mean calf muscle atrophy was 0.7 cm in the first group (range: 0.5-2.5) and 0.6 cm (range: 0.7-2.5) in the second group. According to the plantar strength evaluation made with the mechanic dynamometer, which compared the recovered tendon to that in the patient's healthy leg, a loss of strength greater than 25% was detected for 2 patients in each group (9.5%-10%). None of our patients demonstrated a loss of plantar flexion greater than 10° (Table 2).

With regard to complications, none of the patients in either group experienced complete rerupture, deep infection, sinus formation, or skin ulceration. In the

Table 2. Evaluation of the patients in both groups according to the scoring system outlined by Thermann et al. for Achilles tendon ruptures (14-15).

Category	Score	Group 1 average value	Group 2 average value
<b>Dorsiflexion difference</b>			
No difference	10	7.3	7.1
1-5 grades	5		
6-10 grades	1		
>10 grades	0		
<b>Plantarflexion difference</b>			
No difference	10	8.4	8.2
1-5 grades	5		
6-10 grades	1		
>10 grades	0		
<b>Calf muscle width</b>			
No difference	10	6.7	6.9
<1 cm	5		
1-2 cm	3		
>2 cm	0		
<b>Thompson test</b>			
Positive	5	5	5
Negative	0		
<b>Plantar flexion strength %</b>			
95-100	10	8.1	8
85-94	8		
75-84	6		
65-74	2		
<b>Rising on the toes of one foot</b>			
Complete 1 min	10	8.6	8.5
Incomplete 10 s	5		
Trying	1		
Impossible	0		
<b>Pain</b>			
None	10	8.6	8.7
During maximum effort	5		
During moderate effort	1		
During normal effort	0		
<b>Decline in strength</b>			
None	10	8.5	8.7
Maximum effort	8		
Moderate effort	3		
Normal effort	0		
<b>Sport/daily activity loss</b>			
No	10	7.4	7.3
Minimal loss	8		
Moderate loss	6		
Restricted	2		
<b>Sensitivity to weather cond.</b>			
Negative	5	4.3	4.5
Positive	0		
<b>Evaluation of the treatment</b>			
Very Good	10	8.8	8.9
Good	8		
Moderate	6		
Insufficient	2		

first group, 1 patient (4.7%) developed hypertrophic scar tissue. A superficial skin infection was seen in 2 (9.5%) patients from the first group and 3 (15%) patients from the second group; all recovered after receiving antibiotic treatment (cefazolin sodium). Finally, 1 (5%) patient in the second group developed a partial rerupture in the fourth month of treatment and was treated by a cast orthosis.

Ultimately, 17 (81%) patients from the first group and 16 (80%) patients from the second group were able to return to the athletic activities in which they had been engaged before the trauma. Only 1 patient in each group stated that the treatment was insufficient (Table 2).

## Discussion

Today, the treatment of acute Achilles tendon ruptures is still a matter of discussion. Many treatment methods have been described, including open surgery, percutaneous surgery, and conservative methods. Some authors prefer the conservative method as a way of avoiding surgery and injury complications in addition to the low cost (5,16). McComis et al. (15) saw good or excellent results in 80% of the 15 patients whom they treated with the conservative treatment. Nistor (16) conducted a prospective study that compared conservative and surgical treatment methods and did not find any significant difference between these 2 techniques. It has been ascertained that the complication rate is higher with the surgical treatment; some authors have pointed out, however, that the chance of rerupture after the conservative treatment is significantly higher in comparison to surgical treatment (5,17,18). In a prospective study of 122 patients, Möller et al. witnessed a rerupture incidence of 20.8% with conservative treatment and 1.7% with surgery (5). In our study, complete rerupture was not seen in any of the groups. Only one patient in the second group experienced a partial rerupture in the fourth month of the treatment and was treated with conservative methods.

Among the surgery methods are percutaneous, mini-open, and open repair methods. The advantages of percutaneous surgical repair are the shorter operation time and reduced risk of injury complications (19). However, that tendon length and

tonicity cannot be preserved, that the rerupture risk is high, and that sural nerve lesions are frequently seen are the disadvantages of this method as compared to open repair (19).

The main goal of open repair is to revive the patients functionally and clinically by preserving the tendon's length, tonicity, and anatomy (6-8,20). Open repair consists of basic end-to-end repair and the augmentation repair, in which different tendons and fascia grafts are used (9,10). The primary end-to-end repair method is the most often used repair method for acute Achilles tendon ruptures (21). A variety of different node techniques are used in this method, including the modified Kessler, Krackow, and Bunnell techniques (22,23). Of these, the Bunnell and Krackow techniques strengthen the tendon the most (21). The strength maintained by the primary repair of the tendon rupture depends both on the suture technique and the suture materials. Among these materials are 2 polydioxanone (PDS), 1 PDS, 2 Vicryl, 1 Vicryl, 2 Ethibond, and 1 Prolene. In a study by Yildırım et al. (24), it was shown that 2 PDS sutures have the highest tendon-holding capacity and 2 Ethibond has the lowest. In our study, 1 PDS was used as the suture material and the modified Kessler technique was used in both patient groups.

After the primary repair, several tendons and fascias have been used to strengthen the Achilles tendon (12). Among these, the mostly frequently used are the plantaris tendon, the peroneus brevis tendon, and the gastrocnemius fascia. In our study, augmentation with the plantaris tendon was administered only to patients in the first group.

In our study of acute Achilles tendon ruptures, primary end-to-end repair and primary repair augmented with the plantaris tendon were functionally and clinically compared and the complications were evaluated. In previous studies, researchers were unable to prove the superiority of the augmentation repair method to the end-to-end repair. In a prospective study with 30 patients, Aktas et al. compared end-to-end repair and the plantaris tendon-augmented primary repair. According to this study, no statistically significant functional or clinical differences were found (8). Our study returned similar results. In the first group, the mean AOFAS score was calculated to be 94 (range: 73-100); in the

second group, it was 94.4 (range: 76-100). According to the Achilles tendon evaluation scoring, the first group's mean score was determined to be 81.7 (good, range of 60-96) and the second group's mean score was found to be 82.4 (good, range of 71-94). There were no significant statistical differences between the 2 groups in either of the scoring systems. In the study conducted by Aktas et al. (8), rerupture was not seen in either group; only one patient, who had undergone plantaris tendon augmentation, developed a deep surgical infection. No rerupture was seen in either of the groups involved in our study although one patient who underwent end-to-end repair developed a partial rerupture in the fourth month. In a study of 314 patients by Winter et al. (6), augmentation with the triceps surae muscle was performed during the Achilles tendon rupture repair. A number of complications were observed in that study, however: 10 (3.2%) patients developed deep infections, 4 patients (1.3%) suffered sural nerve damage, and 2 patients (0.6%) experienced sinus formation on the skin. In a study undertaken by Akgün et al. (21), amplification with the plantaris tendon was made after primary repair was completed in 36 patients using the Krackow method. Although 5 patients in that study exhibited surface injury infections, none of the patients developed deep infections or skin necrosis.

In our study, major complications such as deep surgery infection, skin ulceration, or injury necrosis were avoided in both groups. Superficial skin

infections were seen in 2 (9.5%) patients in the first group and 3 (15%) patients in the second group; all 5 cases improved with oral antibiotic treatment. Sural nerve damage was not seen in either of the groups.

In some experimental studies, it has been seen that repair techniques that included augmentation caused the amount of collagen to increase and the tendon to become stronger, and, as a result, the patients were allowed to move again earlier (25). In other clinical studies, however, the clinical and functional advantages of the primary repair with augmentation compared to the end-to-end repair could not be shown (4,8). Moreover, surgical techniques involving augmentation have been seen to result in hypertrophic scars, formed because of the long surgery incision, and deep vein thrombosis because of the long operating time (8,25). In our study, 1 (4.7%) patient in the first group developed hypertrophic scar tissue. None of our patients experienced deep vein thrombosis.

No statistically significant functional or clinical differences were found between these 2 surgical techniques for repairing acute Achilles tendon ruptures. In the surgery method with augmentation, the risk of mortality and morbidity is higher due to a larger skin incision and longer operation time. Our final conclusion is that repair including augmentation is a method that should be preferred in cases of chronic, neglected, and defective Achilles tendon ruptures.

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