İHMAL EDİLMİŞ AŞİL TENDON RÜPTÜRLERİNDE PRİMER ONARIM VE PLANTARİS TENDONU İLE ÖGMENTASYON TEKNİĞİNİN ORTA DÖNEM SONUÇLARI

Mid-Term Results of Primary Repair and Plantaris Tendon Augmentation Technique in Neglected Achilles Tendon Rupture

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ÖZET

Amaç: İhmal edilmiş Aşil tendon rüptürlerine uyguladığımız primer onarım ve plantaris tendonu ile ögmentasyon tekniğinin klinik ve fonksiyonel sonuçlarını değerlendirmek.
Gereç ve yöntemler: Bu çalışmada 2011-2014 yılları arasında ihmal edilmiş Aşil tendon rüptürü nedeniyle, primer onarım ve plantaris tendonuyla ögmentasyon tekniği ile cerrahi tedavi uyguladığımız yirmi hasta retrospektif olarak incelendi. Hastalar son takiplerde klinik olarak Amerikan Ortopedik Ayak ve Ayak Bileği Topluluğu (AOFAS) arka ayak skoru, Vizüel Ağrı Skalası (VAS) skoru, baldır çevresi uzunluğu, topuk yükseltme testi ve ayak bileği eklem hareket açıklığı dereceleri ile değerlendirildi.
Bulgular: Yaralanma ile ameliyat arasında geçen süre ortalama 7,8 (4-16) hafta olarak bulundu. Ameliyat sırasında tendon güdükleri arasındaki ortalama defekt miktarı 44 (30-75) mm olarak ölçüldü. Ortalama takip süresi 62 (56-84) aydı. Son takiplerde AOFAS skoru ortalaması 93,6 (86-100) olarak bulundu ve VAS skoru tüm hastalarda sıfırdı. Ortalama baldır çevresi uzunluğu, ayak bileği plantar fleksiyon ve dorsifleksiyon dereceleri etkilenmemiş taraf ile karşılaştırıldığında istatistiksel olarak anlamlı farklılık saptanmadı (p değerleri sırasıyla 0,40-0,59-0,68). Bir hasta hariç tüm hastalar topuk yükseltme testini gerçekleştirebilmekteydi. Bir hastada antibiyotik tedavisi ile iyileşen yüzeysel cilt enfeksiyonu gözlendi. Hiçbir hastada derin ven trombozu, cilt nekrozu ve tekrar rüptür tespit edilmedi.
Sonuç: İhmal edilmiş Aşil tendon rüptürlerinde, primer onarım ve plantaris tendonu ile ögmentasyon tekniği, orta dönemde, klinik ve fonksiyonel olarak başarılı sonuçlar ile ilişkilidir

Anahtar Sözcükler: *Aşil; Tendon; Rüptür; İhmal edilmiş; Kronik; Plantaris.*

ABSTRACT

Objective: To assess clinical and functional outcomes of primary repair and plantaris tendon augmentation technique employed in neglected Achilles tendon rupture.
Methods: We retrospectively reviewed 20 patients underwent surgical treatment with primary repair and plantaris tendon augmentation technique for neglected Achilles tendon rupture between 2011 and 2014. At the last follow-up, the patients were clinically assessed by American Orthopedic Foot & Ankle Society (AOFAS) hindfoot score, Visual Analogue Scale (VAS) score, calf circumference, single-limb heel rise test and range of motion in ankle.
Results: Mean time from rupture to surgery was 7.8 weeks (range 4-16 weeks). The mean gap was 44 mm (range 30-75 mm). Mean postoperative follow-up period was 62 months (range 56-84 months). At the last follow-up, mean AOFAS score was 93.6 (range 82-100) while VAS score was found as zero in all patients. No significant difference was detected in mean calf circumference and plantar flexion and dorsiflexion range of ankle between involved site and contralateral intact site (p=0.40; p=0.59 and p=0.68, respectively). One patient suffered from superficial skin infection which was treated successfully with antimicrobial therapy. There were no cases of deep-vein thrombosis, skin necrosis, or re-rupture.
Conclusion: In neglected Achilles tendon rupture, primary repair and plantaris augmentation technique is associated with successful clinical and functional outcomes at mid-term.

Keywords: *Achilles; Tendon; Rupture; Neglected; Chronic; Plantaris*

INTRODUCTION

Although the diagnosis is straightforward in the presence of awareness for probability of Achilles tendon rupture, approximately 20% of Achilles tendon ruptures is neglected by either clinicians or patients [1, 2]. Achilles tendon rupture was considered neglected if presented beyond four weeks after the index injury [3-6]. The patient with neglected Achilles tendon rupture experience difficulty in daily activities such as climbing stairs or pain-free load-bearing of injured extremity [7]. Surgical treatment is recommended in neglected Achilles rupture unless there are severe skin problems or uncontrolled diabetes mellitus [7-9]. However, in neglected ruptures, treatment differs from acute cases since tendon stumps become retracted, making repair challenging [9]. In addition, debridement is performed to scar tissue between tendon ends until exposing healthy tissue; thus, resulting defect could not be always predictable [7]. Thus, several techniques have been employed in the treatment including V-Y tendinous flap [4], gastrocnemius-soleus turn-down flaps [10-12], tendon transfer [5, 7, 13, 14] and reconstruction with synthetic materials [15, 16]. But, since none of these managed to offer results based on findings by themselves, method's superiority against each other is still debated (17).

In the present study, we aimed to assess clinical and functional outcomes of primary repair and plantaris tendon augmentation technique employed in neglected Achilles tendon rupture. Our hypothesis is that successful clinical and functional outcomes with low complication rate can be achieved with this technique in neglected Achilles tendon rupture.

METHODS

Patients selection

The study was approved Institutional Review Board of Karabük University. All patients gave written informed consent. We retrospectively reviewed 20 patients underwent surgical treatment with primary repair and plantaris tendon augmentation technique for neglected Achilles tendon rupture between 2011 and 2014. Data were extracted from hospital database including patient files and outpatient medical records. The patient with history of steroid use, those with incomplete data and patients with previous musculoskeletal disease that may have influence on clinical outcomes were excluded. The final study population included 20 male patients with complaints of ankle pain and difficulty in walking and climbing stairs. The diagnosis of Achilles tendon rupture was made according to findings in clinical examination (including positive Thompson test, inability to perform single-limb heel rise and limping) and on preoperative magnetic resonance imaging.

In all patients, injury occurred during a sports activity. While ten of the patients were not diagnosed in emergency departments, eight of them did not go to doctor after the trauma. Two patients were unsuccessfully treated with conservative methods in another center. Mean age was 37 years (range 28-49 years) at time of diagnosis (Table 1). Mean time from rupture to surgery was 7.8 weeks (range 4-16 weeks). Mean body mass index was 26.2kg/m2 (range 17.1-29.8 kg/m2). There was right-dominance in all patients; however, injury was at right side in 15 patients and at left side in five patients. With regard to co-morbidities, two patients had hypertension.

Table 1. Characteristics of patients.

Characteristics	Patients (N = 20)
Age# (years)	37 (28 to 49)
Sex*	
Male	20 (100%)
Female	0 (0%)
Side*	
Right	15 (75%)
Left	5 (25%)
Body mass index# (kg/m²)	26.2 (17.1 to 29.8)
Interval from injury to the surgical# (week)	7.8 (4 to 16)
Length of gap# (mm)	44 (30 to 75)
Follow-up period# (months)	62 (56 to 84)
AOFAS score# (points)	93.6 (86 to 100)

Surgical technique

The patients were placed on operation table in prone position. A 10-to-15 cm posteromedial longitudinal skin incision was made beginning from 2-cm medial to Achilles tendon. Paratenon was exposed by excising subcutaneous tissue at midline. The paratenon was

opened longitudinally at midline, exposing defect (Figure 1-A). Mean gap was 44 mm (range 30-75 mm). Irregular rupture endings and scar tissue were excised while ankle was at neutral position and 1-0 polydioxanone was used to attach by modified Kessler stitching technique. For primary suture, various position one Achilles tendon were applied by using 2-0 polyglycolic acid absorbable suture. Plantaris tendon was released from proximal muscle tendon complex (Figure 1-B). The plantaris tendon was rotated in a way to enclose proximal and distal parts of Achilles tendon rupture. The proximal end of plantaris tendon was expanded to form a membrane-like structure as described by Lynn et al., which was then used a patch at repair site (Figure 1-C) [18]. In three patients with injured plantaris tendon, the tendon was released from proximal end to form a free flap and same procedure was applied. The paratenon was stitched back to tendon (Figure 1-D). Fascia, subcutaneous tissues and skin were closed.

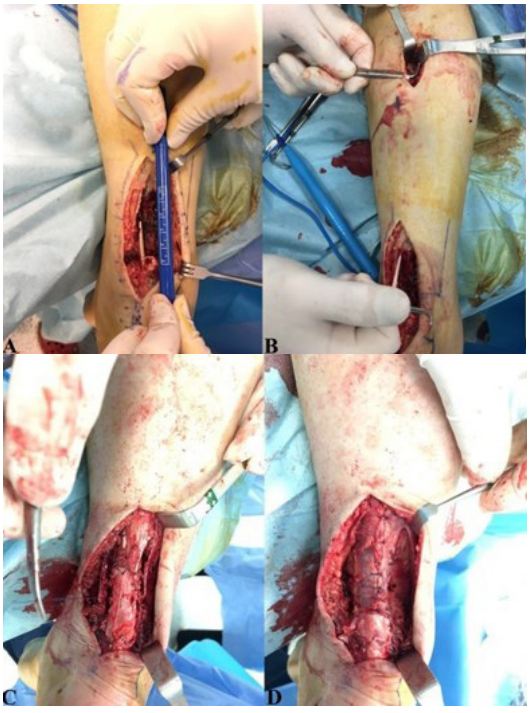

Figure 1. A-D. Intraoperative images of primary repair and plantaris tendon augmentation technique. Extent of defect between tendon stump before repair (A); Exposure of plantaris tendon at proximal and release from musculo-tendinous junction (B); Patch process of plantaris tendon after full rotation and making it a membrane-like structure (C); Closure of paratenon after repair (D).

Short-leg circular plaster was applied at 10° plantar flexion. The plaster was removed on day 15 after surgery and sutures were also removed. The patient worn ankles brace allowing plantar flexion with limited dorsiflexion (0°) and adjustable angles over next two weeks. In addition passive plantar flexion exercises were prescribed. No active movement was allowed during this period. At the end of week four, partial load-bearing was applied with a device as tolerated and full load-bearing was achieved on week eight. The dorsiflexion was allowed on week eight. On week 12, a rehabilitation program including general strengthening program, standing on the balls of the feet and progressive resistance exercises were applied.

Clinical Evaluation

At the final follow-up, the patients were clinically assessed by American Orthopedic Foot & Ankle Society (AOFAS) hindfoot score, Visual Analogue Scale (VAS) pain score, maximum calf circumference, ability to perform single-limb heel rise and range of motion in ankle. AOFAS scores incorporate objective and subjective factors into numerical scales to describe pain, function and alignment [19]. The VAS pain score includes 10-points scale (0, no pain; 10, severe pain). Calf atrophy was evaluated by measuring the maximum calf circumference in both legs. We confirmed the distance from the patellar apex to the point of measurement in both legs for standardization [20]. Range of motion was measured by two arm goniometer. The fulcrum of goniometer was fixed to below lateral malleolus; then, first arm was positioned as being parallel to long axis of fifth metatarsal while second arm was positioned as being parallel to fibula. Active dorsiflexion and plantar flexion were measured in both ankles. To assess the function of the gastrocnemius-soleus-Achilles tendon complex, patients were asked to perform 10 single-limb heel rises on the affected side and were assessed as being either able or unable to do so [20, 21]. Medical and surgical complications were recorded intraoperatively and postoperatively.

Statistical analysis

Statistical analysis was performed using the statistical package SPSS software (Version 17.0, SPSS Inc., Chicago, IL, USA). The distributions of the variables

were analyzed using the Kolmogorov–Smirnov test. The Wilcoxon test was used to analyze the results for the ruptured and non-ruptured sides at the time of the latest follow-up. Values of $p < 0.05$ were considered statistically significance.

RESULTS

Mean postoperative follow-up period was 62 months (range 56-84 months). At the last follow-up, mean AOFAS score was 93.6 (range 82-100) while VAS score was found as zero in all patients. Mean calf circumference was measured as 36.9 cm (range 29.5-40 cm) and 37.8 cm (range 31-41 cm) in involved and uninvolved sides, respectively. No significant difference was found ($p = 0.40$; Table 2). Mean dorsiflexion angle was 20.2° (range 15-30°) and 19.4° (range 15-30°) in involved and uninvolved ankles, respectively, with no significant difference between them ($p = 0.68$). Mean plantar flexion angle was 43.8° (range 40-50°) and 44.6° (range 40-55°) in involved and uninvolved ankles, respectively, with no significant difference between them ($p = 0.59$). At the last follow-up examination, all except one patient could perform a single-limb heel rise.

Table 2. Comparison of calf circumference and plantar flexion and dorsiflexion of ankle between involved and uninvolved sides.

	Ruptured side	Non-ruptured side	Pvalue
Plantar flexion (degrees)	43.8 ± 3.9 (40 to 50)	44.6 ± 5.0 (40 to 55)	0.59*
Dorsiflexion (degrees)	20.2 ± 2.5 (15 to 30)	19.4 ± 2.2 (15 to 30)	0.68*
Calf circumference (cm)	36.9 ± 3.1 (29.5 to 40)	37.8 ± 2.9 (31 to 41)	0.40*

The values are given as the mean and standard deviation, with the range in parentheses.
*Analyzed with a Wilcoxon test; $p< 0.05$.

One patient suffered from superficial skin infection which was treated successfully with antimicrobial therapy. There were no cases of deep-vein thrombosis, skin necrosis, or re-rupture. Patients returned to their works in 12.8 weeks (10-18 weeks) on average (Figure 2).

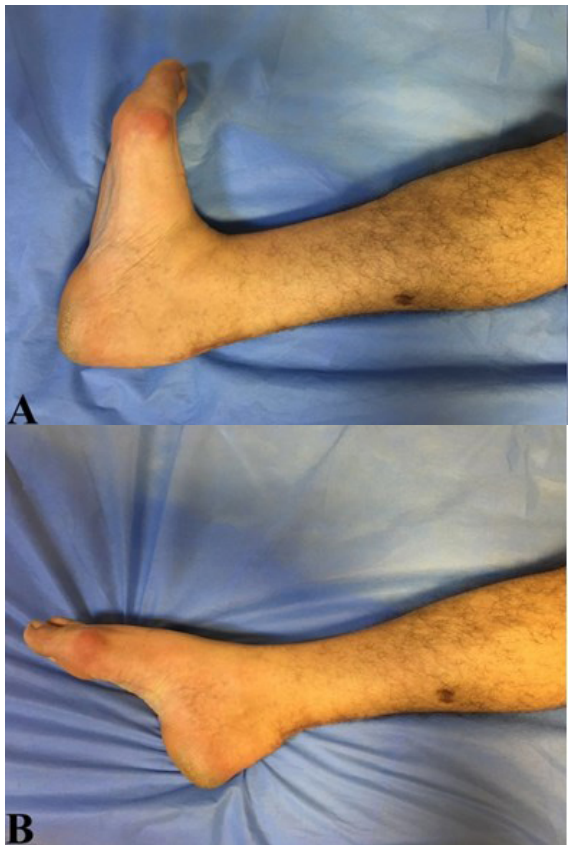

Figure 2.A and B. Clinical images of a patient underwent primary repair and plantaris tendon augmentation. Ankle dorsiflexion (A) and plantar flexion (B).

DISCUSSION

In parallel to increased engagement in sport activities, the incidence of Achilles tendon rupture has been increased and number of patients with neglected Achilles tendon rupture (unnoticed by patients or overlooked in medical facilities) is also increased as a result. Some patient may disregard pain, swelling around ankle which masks gap and be able to perform plantar flexion using flexor tendons and Thompson test results are questionable in some extends, all of which are primary causes of misdiagnosis in Achilles tendon rupture. In cadaver studies, Cuttica et al. showed that Thompson test may be negative even if 75% of Achilles tendon was ruptured; thus, Thompson test may produce inaccurate results unless Achilles tendon was ruptured completely [22]. In a study by Surel et al., it was shown that, of the patients with neglected Achilles

tendon rupture, 25% (n=3) did not seek medical attention while the diagnosis was overlooked in 75% (n=10) despite seek for medical attention [23]. In our study, the diagnosis was overlooked in 10 patients (50%). This may be attributable to increased awareness of emergency clinicians about tendon ruptures in the differential diagnosis of patients presenting with ankle trauma.

In the treatment of neglected Achilles tendon rupture, primary goal is to recover normal muscle function and to maintain continuity of Achilles tendon in order to achieve healing in physiological position [7]. More complicated techniques than used in primary Achilles tendon rupture have been used to achieve this goal [4, 5, 7, 10-16, 24]. In the literature, good functional outcomes have been reported with mean AOFAS score ranging from 85.86 to 98.91 [12, 24]. In our study, mean AOFAS score was found to be 93.6 in agreement with literature. In addition, no significant difference was found in calf circumference, active dorsiflexion and plantar flexion between involved and contralateral, uninvolved sides. All but one patient could able to perform single-limb heel rise test. Thus, it may be suggested that primary repair and plantaris tendon augmentation technique is successful in the treatment of neglected Achilles tendon ruptures in agreement to our initial hypothesis.

Although successful outcomes are achieved in general, many techniques used in the treatment of chronic Achilles tendon rupture have some specific disadvantages. In gastrocnemius-soleus turn-down flap technique, there is an alteration in tendon-to-muscle length which may result in contractility changes in gastrocnemius-soleus muscle complex [25]. Although peroneus longus has more contribution to ankle eversion when compared to peroneus brevis (almost 2-folds) [26], it was reported that difficulty in eversion-related activities was developed in younger, competitive athletes [27]. Flexor hallucis tendon transfer may cause difficulty with the loss of push-off from the hallux when sprinting [9]. There is no limitation related to plantaris tendon in our technique. In previous cadaver studies, plantaris tendon was identified in 90-97.5% of subjects [28, 29]. In the literature, it was suggested that the rate further reduced in patients with Achilles tendon rupture [28]. The lack of plantaris tendon is the limiting factor for this technique. However, plantaris tendon was present in all patients in our study. Again, in a cadaver study, it was shown that calcaneal insertion of plantaris tendon may be separate from Achilles tendon. This finding in attributed to fact that plantaris tendon is generally intact in Achilles tendon rupture [30, 31]. In our study, plantaris tendon rupture was observed in only three patients and plantaris tendon was augmented to repair site as free flap as described by Lynn et al. In the technique described by Lynn, plantaris tendon is detached from calcaneal insertion unless it was ruptured [18]. In a cadaver study, it was shown that plantaris tendon blood supply is supplied via paratenon by trans-fascial branches (2-4) of posterior tibial artery at lower-middle portion of the leg. In addition it was noted that there is one or two arterial anastomosis at 5-8 cm to plantaris insertion [32]. In our technique, plantaris tendon is detached at proximal musculo-tendinous junction, preserving blood supply of plantaris tendon partially.
In a systematic review, it was reported that infection was seen by 7.6% whereas wound problems by 4.7%, sural nerve injury by 1.8%, deep vein thrombosis by 1.2% and postoperative pain and tendinopathies by 1.2% after treatment of chronic Achilles tendon [17]. In our study, superficial infection was observed in only one patient. No re-rupture, deep vein thrombosis, postoperative persistent pain and clinical sural nerve injury was observed in our study.

This study has some limitations including retrospective design and lack of control group. In this study, six patients were excluded due to missing data during follow-up. To the best of our knowledge, there are few randomized, controlled studies regarding chronic Achilles tendon rupture in the literature. Current literature provides insufficient evidence about optimal treatment modality in neglected Achilles tendon rupture. Thus, further randomized, controlled studies are needed.

CONCLUSION

In conclusion, primary repair and plantaris tendon augmentation technique is successful in clinical and

functional manner in mid-term. This technique is associated with advantages like protection of the vascular link due to the protection of plantaris tendon distal, added strengthening by going through the Achilles tendon, prevention of future cohesions due to proximal plantaris tendon end being opened like a membrane and stitched onto the Achilles tendon, prevention of complications due to other tendon transfers.

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