



Evaluation of the surgical results of Achilles tendon ruptures by gait analysis and isokinetic muscle strength measurements

Aşil tendon yırtıklarında cerrahi tedavi sonuçlarının yürüme analizi ve kas gücü ölçümüyle değerlendirilmesi

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Amaç: Aşil tendonu yırtığı nedeniyle cerrahi tedavi uygulanan hastalarda uzun dönem sonuçlar değerlendirildi.

Çalışma planı: Aşil tendonu yırtığı nedeniyle 15 erkek hastaya (ort. yaş 39.5; dağılım 28-58) cerrahi tedavi uygulandı. Bir olgu dışında, tüm yaralanmalar aktif spor yaparken oluşmuştu. On bir hasta travmadan sonra bir hafta içinde ameliyat edildi. Ameliyattan dört hafta sonra alçı sonlandırılarak dorsifleksiyona izin vermeyen polietilen splint uygulandı. Kısmi yük vermeye dördüncü haftadan itibaren başlandı. Hastalar Thermann ve ark.nın skorlama sistemiyle objektif ve subjektif olarak değerlendirildi. İzokinetik dinamometre ile kas gücü ölçüldü ve yürüme analizi yapıldı. Sonuçlar sağlam ayaklardan elde edilen verilerle karşılaştırıldı. Ortalama izlem süresi 16.8 ay (dağılım 8-48 ay) idi.

Sonuçlar: Yedi hasta (%46.7) hiç ağrı olmadığını, altı hasta (%40) ağır, bir hasta (%67) orta ağır, bir hasta (%67) da hafif antrenman sırasında ağrı olduğunu belirtti. Dokuz hastada (%60) güç azalması hiç olmadı. Yedi hasta (%46.7) yaralanma öncesindeki aktivite düzeyine ulaştı. Subjektif değerlendirmede, 12 hasta (%80) uygulanan tedavinin çok iyi veya iyi olduğunu belirtti. Objektif ölçümlerde ameliyatlı taraf, karşı tarafa ortalama 0.43 cm incelmış bulundu. Sonuçlar dokuz hastada (%60) çok iyi veya iyi, dördünde (%26.7) orta, ikisinde (%13.3) kötü idi. Bir hastada yüzeysel enfeksiyon ve yara iyileşmesi sorunu izlendi. İzokinetik ölçümlerde zirve torkta azalma, toplam işte ise artma gözlemlendi. Yürüme analizinde dorsifleksiyon veya plantar fleksiyon farkı ile önyakta yer tepkimesi kuvveti farkı arasında anlamlı ilişki bulunmadı.

Çıkarımlar: Aşil tendonu yırtılmalarında erken uygulanan cerrahi tedavi, kısa süreli immobilizasyon ile birlikte iyi sonuç vermekte, uzun dönemde hasta memnuniyeti yüksek olmaktadır.

Anahtar sözcükler: Aşil tendonu/yaralanma/cerrahi; yırtık; tendon yaralanması/cerrahi.

Objectives: We evaluated the long-term results of surgical treatment of Achilles tendon ruptures.

Methods: Fifteen male patients (mean age 39.5 years; range 28 to 58 years) underwent surgery for Achilles tendon ruptures. All the ruptures but one occurred during sport recreations. Eleven patients were treated within the first week of trauma. After surgery, a cast was applied for four weeks, after which it was switched to a polyethylene splint that did not allow dorsiflexion. Partial weight bearing was allowed in the fourth postoperative week. Subjective and objective evaluations were made according to the system by Thermann et al. Muscle strength was measured by an isokinetic dynamometer and gait analysis was performed. Data from the healthy sides were used for comparisons. The mean follow-up was 16.8 months (range 8 to 48 months).

Results: Seven patients (46.7%) had no pain, while six patients (40%), one patient (6.7%), and one patient complained of pain during heavy, medium, and light sports activities, respectively. Muscle strength did not decrease in nine patients (60%). Seven patients (46.7%) returned to preinjury activity levels. Twelve patients (80%) evaluated the outcome as very good or good. The mean muscle atrophy on the affected side was 0.43 cm. The overall results were very good or good in nine patients (60%), moderate in four patients (26.7%), and poor in two patients (13.3%). One patient had superficial infection and delayed healing. Isokinetic measurements showed decreased peak torque, and increased total work. By gait analysis, no significant relationship was found between the dorsiflexion and plantar flexion difference and forefoot ground reaction forces.

Conclusion: Early surgical treatment of Achilles tendon ruptures followed by a shorter immobilization period is associated with satisfactory results, and in the long-term, with a higher rate of patient satisfaction.

Key words: Achilles tendon/injuries/surgery; rupture; tendon injuries/surgery.

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The incidence of Achilles tendon ruptures has increased as a result of increasing participation of the society in sportive activities.^[1-3] The treatment of these ruptures is still controversial. The purpose of the therapy is to protect the length and stretch of the tendon to provide the strength of gastrocnemius and soleus muscle complex. The treatment modalities are separated into three: Open repair, percutaneous repair and conservative methods. Plaster fixation is the most frequently employed conservative method. It is clear that the healing process is carried out by the paratenone which remains intact during the rupture. However, it was observed the rupture reoccurs by a ratio of 13-30% in patients treated with conservative methods.

Nevertheless, conservative treatments is preferred since it gives similar results and lesser complications to other modalities.^[2,4,5] Since prolonged immobilization results in muscle atrophy and loss of strength in cruris, it was claimed that shorter immobilization associated with functional therapy gave much better result in long term basis.^[2]

It was claimed that in tendons treated with percutaneous method resulted in 50% loss in strength, the recurrence of the rerupture has increased and sural nerve lesion was developed in most of the applications.^[4,6,7]

In last two decades the open repair is recommended as the first choice for especially athletic and active people. There are many techniques defined in this respect. Bunnel and Kessler first described end to end repair.^[4] There are also different techniques developed such using fasial grafts in order to strengthen the sutures, the use of plantaris tendon, peroneal and tibial muscles as grafts and the use plastic tendons and vascular grafts.^[2,4,6,8,9]

Achilles tendon ruptures come third as regards to incidence of ruptures after rotator cuff and quadriceps tendon.^[1-4, 6, 10] Most of the ruptures occur in sports activities (83%) and much more prevalent in males. Most of the patients are sedentary males with occupation at the ages of 30- 40 who are occasionally involved in sports activities.^[2]

In this study the long term consequences of the surgical therapy were objectively and subjectively evaluated by gait analysis and isokinetic muscle strength measurements.

Patients and method

15 male patients with Achilles tendon rupture were treated with surgical therapy between 1998 - 2001 (the average age of the patients were 39.5 ranging between 28 and 58 years of age). The rupture was at the left side in eight cases, right side in seven cases and dominant side in six cases. Except in one case the rupture has occurred when the patients were doing active sports. It occurred when playing football in 11 cases, volleyball in two cases, jumping rope in one patient and walking as a result of twisting of an ankle in one patient

The rupture was operated in the early stage (within the first post traumatic week) in eleven and in the late stage (after the first post traumatic week) in four patients. Two of the patients who were operated at the late stage were subjected to tendon repair with Bosworth technique and the remaining 13 patients were operated with Lindholm tendon repair method.^[4,6,8] The patients were operated after cast and prophylactic antibiotic application. Two of the patients were reoperated due to postoperative early stage infection and reaction against sutures.

Ten patients were plastered with short leg cast. The patients were allowed to walk with one or two support sticks at the first or second post operative day and they were discharged provided that they would carry out isometric exercises at home. The plaster was removed at the fourth post operative week and a polyethylene splint which kept the ankle at neutral position and did not allow dorsal flexion was applied. After the fourth post operative week the patients were allowed to step on their foot with the application of partial load bearing. The amount of load applied was gradually increased and the patients were suggested to apply a full load 12 week after the operation. The average follow up period was 16.8 months (8-48 months).

The patients were both objectively and subjectively evaluated by the use of a scoring system developed by Thermann et al.^[11] According to this system 90-100 points is very good, 80-89 points is good, 70-79 points is moderate and 60-69 points is poor.

Isokinetic tests were carried out with CYBEX-350 isokinetic dinamometer (Lumex Inc., Ronkoma,

USA). The power and strength tests were performed with 3, 10 and 20 times repeated extension at a rate of 30 and,120 degrees / second keeping the patient at prone position and hips and knees were at full extension. The power was measured by the total work (torque x distance) and the strength was measured by peak torque (force (N) x distance(m))

At the final stage of the study the patients were subjected to gait analysis . The foot pressure distribution was evaluated by the use of EMED-SF (Novel GmbH, Munich, Germany). The 445 mm x 225 mm sensitive monitors of the apparatus were mounted onto a 7m x1 m walking platform. The platform was covered with a non- transparent cover. The patients were given an ample time to get use to the medium and the platform. However the patients were not given any information about the place of the sensitive plates. They were asked to walk on the platform with a place they preferred. Both feet of the patients were analyzed three times. The data obtained from the intact feet were taken as the control group. The dynamic and static pressure map of the feet were taken by the use of the platforms which measured the floor reaction strength and pressure variations in the foot, heel and the forefoot during the walking phase . All the data obtained from the inured foot were compared with the intact foot. The statistical data of the dorsiflexion, plantar flexion , leg circumference, peak torque, total work, the duration of the stand up phase, the duration of twisting with the fore foot, the ground reaction force of the forefoot and the heel were recorded. The data obtained were evaluated Wilcoxon signed-rank test. p<0.05 value was accepted as significant.

Results

Seven patients (%46.7) had no pain, six patients (40 %) complained from pain during medium to heavy sport activities and one patient (6.7%) complaint from pain in slight exercise . In nine patients (60%) there was no loss of strength in the operated side while four patients (26.7 %) complained from the loss of strength in heavy and two patients(13.3%) had a loss of strength in medium to heavy activities (26.7%) . Seven patients (46.7%) were observed to reach to their pre injury activity levels. Slight loss in the sportive activity of two patients was observed (13.3%) and there was a serious loss of activity in six patients (40%)

The subjective evaluation of the patients showed that the therapy applied was very good in six (40%), good in six (60%) and average in three (20%) patients. The objective measurements revealed that the operated side had an average muscle atrophy of 0.43 cm compared tp the opposite side . The measurements were made 10 cm distal of tuberositas tibia. The outcome was regarded as “very good” in four (%26.7) , “good” for five (%33.3) , “average” for two (%26.7) and “poor” for two (%13.3) of the patients. (Table 1)

There was a superficial infection and wound healing complications in one of the patients . Two of the patients were re operated due to early stage infection and suturing reaction. In the movement range of the ankle there was a difference of 1.4 degrees in dorsiflexion (between -8 to 10) , 2.5 difference in plantar flexion (between -5 and 20).

Table 1. Subjective and objective evaluations of the surgical treatment

Evaluation	Percentage
Pain	
None	46.7
During heavy activity	20.0
During moderate- heavy activity	6.7
During slight activity	6.7
Subjective power loss	
None	60.0
During heavy activity	26.7
During moderate- heavy activity	13.3
During slight activity	–
Participation in sport activities	
No difference	46.7
Slightly decreased	13.3
Significantly decreased	40.0
Limited	–
Subjective evaluation of the treatment	
Very good	40.0
Good	20.0
Average	40.0
Poor	–
General evaluation	
Very good	26.6
Good	33.3
Average	26.7
Poor	13.3

Table 2. The difference in muscle strengths of the injured and intact sides measure by Cybx Apparatus

		Lowest %	Highest %	Mean %
Dorsiflexion	Peak torque difference at 30 deg/sec	-13	18	-4.60
	Peak torque difference at 120 deg/sec	-27	35	1.26
	Total work difference at 30 deg/sec	-27	33	-6.06
	Total work difference at 120 deg/sec	-44	42	-0.27
Plantar flexion	Peak torque difference at 30 deg/sec	-33	44	1.53
	Peak torque difference at 120 deg/sec	-35	112	1.80
	Total work difference at 30 deg/sec	-38	59	-5.13
	Total work difference at 120 deg/sec	-50	115	-0.73

There was a limitation of 4 degrees in the movement range. The dorsiflexion was higher in the intact side in two patients (13.3%), lower in four patients (26.6%), the same in both sides in nine patients (60%).

The plantar flexion on the other hand is higher in the intact side in one patient (6.7%), lower in four patients (26.6 %) and the same in ten patients (67 %). There was a decrease in torque and increase in total work in all patients. These were much higher in slow pace (30 degrees /second) than in the fast pace (120 degrees /second) (Table 2)

The comparison of the traumatic and the intact sides revealed that there was not a significant difference in dorsiflexion, plantar flexion, peak torque , total work, the period of stepping phase, the duration of standing, and floor reaction pressure time in heels and feet. ($p>0.05$). Only at a pace of 30 degree/second was there a statistically significant relation in planter flexion, and total work between the intact and traumatic legs ($p<0.05$).

The results of leg periphery strength analysis showed a significant difference in peak torque difference in single plantar flexion at 30 degrees / second ($p<0.05$). There was not a significant difference in forefoot base reaction pressure ($p>0.05$). There was a positive and significant correlation between pre operation period and floor reaction pressure at the heel ($p<0.05$).

Discussion

In Achilles tendon rupture conservative treatment is generally preferred due to advantages such as short hospitalization time, lower anesthetic risk, decreased wound healing complication and early

return to active life.^[2, 12-14] Nistor, recommended the conservative treatment stating that the complication ratio after the surgical treatment is high and there was no difference in functionality between these two modalities.^[15] Carden et al reported the rate of complication after surgical and conservative treatments as 17% and 4%. However they stated that the post treatment recurrence of the rupture in the patients treated with conservative method was much higher. Kelam et.al indicated that the incidence of rerupture after the treatment was 18 % in conservative therapy while it remained only 1 % in surgical approach.^[16] In another meta- analysis study the incidence of post treatment ruptures was found as 3% for surgical and 12 % for conservative therapies.^[2]

In our study the ratio of post treatment complication in surgical approach was found as 13.3 % and there was no post treatment ruptures occurred in any of the patients . However since the conservative therapy does not prevent the elongation of the tendon it not possible to achieve the one of the main objectives of the therapy.^[13, 17, 18] Today where modern anesthesia and physical therapy methods are available, the surgical method is opted for the athletic patients.^[1-4, 6] It was observed that 83% of the patient in surgical therapy and 69% of the patients in conservative treatment reached their pre traumatic activity levels. It was also stated that 93% of the patients subjected to surgical and 66 % of the patients treated with conservative approach were satisfied with final result.^[16] The objective measurements in our study showed that the ratio of “very good” and “good” results was 60%. 80% of the patients indicated that they found the surgical treatment “very good “or“good“. In subjective

evaluations the ratio of the patients who had no or very little loss of strength in leg peripheral muscles was 86 %. 60% of the patients reached their pre traumatic activity levels. In objective evaluations the operated side showed a muscle atrophy of 4.3 mm compared with the opposite side. Scarfi et al reported that there was a decrease of 8 mm in the periphery of the operated side after the Achilles tendon rupture was repaired with percutaneous method.^[17] The objective of the Achilles tendon repair is to establish its length. The excessive elongation of the tendon is not desired. In the case of the elongation in the Achilles tendon one expects an increase in ankle dorsiflexion and decrease in pressure in foot. Armstrong et.al applied percutaneous Achilles tendon elongation in diabetic patients in order to decrease the risk of wound formation related to the increase in forefoot pressure and they obtained 8 degrees increase in foot dorsiflexion and a 27% decrease in foot pressure.^[19]

In order to investigate the tendon elongation consequences in our study the patients treated with surgical approach were subjected to gait analysis and isokinetic muscle power measurements. We met no similar study where the results of surgically treated Achilles tendon ruptures were evaluated by muscle strength tests and gait analysis in literature. These evaluations showed no differences in plantar flexion in ankle, the period of stepping phase, twisting period on foot and base reaction pressure on heel between the intact and traumatic sides which might indicate a significant elongation in Achilles tendon.

In the ruptured side the measured peak torque was found higher and total work was found lower than the intact side. These values were found to be markedly increased in lower rate (30 degree/second) than the higher rate (120 degree/second). In conclusion there were no symptoms indicating loss of strength except at lower rate. Also leg periphery difference and plantar flexion showed a significant positive change with peak torque change at 30 degree/ second. Leppilahti et al. reported that plantar flexion and peak torque changed with rate in surgically treated Achilles tendon ruptures.^[20] In the ruptured side the difference in peak torque was 9% at 30 degree / second, 10 % at 90 degree / second and 2 % at 240 degree / second.^[18, 20]

The period before the operation play an important role in the eventual results. In isokinetic evaluations it was stated that there were 16.5 % and 17.5 loss of strength in plantar flexion and dorsiflexion in the patients followed up for 6-14 months^[21]. In our study at a plantar flexion of 120 degree / second the difference in total work was observed to increase with the increase in waiting period. It was concluded that the delay of operation had an adverse effect on both the muscle strength and speed.

In conclusion surgical treatment is the recommended modality of treatment in Achilles tendon ruptures since it result in long term patient satisfaction with early application and with scrutinizing surgical technique and gave highly good results with short term immobilization with a very little rate of complication and recurrence

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