

The Evaluation of Surgery Applied in Acute Achilles Tendon Rupture with Subjective and Objective Data in Accordance with Isokinetic Muscle Strength Measurement

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Abstract; The aim of this study is to evaluate surgery performed due to acute Achilles tendon rupture in the light of the subjective and objective data obtained from isokinetic muscle strength measurements. The study included 25 patients with acute achilles tendon rupture. The surgical outcomes were evaluated with the AOFAS foot and hindfoot evaluation score, and the data obtained with the Cybex isokinetic dynamometer. The mean AOFAS foot and hindfoot evaluation score was 98.4 ± 3.7 . In the scoring system developed by Thermann et al., the mean value was 89.2 ± 6.8 . Accordingly, 13 (52%) of the patients had excellent, 11 (44%) good and 1 (4%) moderate results. In the subjective evaluation, 21 (84%) of the cases were evaluated as excellent, 3 (12%) as good and 1 (4%) as fair. Calf circumference was measured as mean 38.8 ± 3.7 cm on the operated side and 39.8 ± 3.4 cm on the contralateral side, and the difference was not considered statistically significant ($p > 0.05$). In the measurements made with the isokinetic dynamometer, no significant difference was determined between the healthy and operated sides in respect of the 30°/sec plantar flexion-dorsiflexion peak torque, 120°/sec plantar flexion peak torque and total work measurements ($p > 0.05$). The 120°/sec dorsiflexion peak torque value was found to be statistically significantly higher in the operated ankle ($p < 0.05$). Although there is no consensus about the treatment protocol for achilles tendon ruptures to be selected, considering the patient profile, methods that allow early active movement, shorten the immobilization period, minimize the loss of work force, and increase patient satisfaction with a low complication rate should be chosen. In this respect, open surgical procedures can be considered the most suitable treatment method for achilles tendon ruptures.

INTRODUCTION

With increased community participation in sport, there has been an increase in the frequency of Achilles tendon rupture¹⁻³. The treatment of these ruptures remains a matter of debate. The aim of treatment is to provide the optimum strength of the gastrocnemius and soleus muscle complex with preservation of the length and tension of the tendon. Treatment methods are categorised in 3 groups as open repair, percutaneous repair, and conservative methods.

Fixation with plaster cast is the most frequently applied conservative method. It has been claimed that it provides healing of the paratenon which remained intact during the rupture. However, re-rupture has been reported to occur in 13-30% of patients applied with conservative treatment^{3,4}. Nevertheless, conservative treatment is selected as complications are few and the functional results obtained are similar to those of other methods^{3,4}. As thinning in the cruris and loss of strength as a result of decreased function have been observed in long-term immobilization, it has been reported in recent years that the use of functional treatment methods with shorter-term immobilization has obtained better results in the long-term³.

In tendons applied with percutaneous repair, loss of strength at the rate of 50% and high rates of re-rupture have been seen, and the development of sural nerve lesions in the majority of cases^{5,6}.

Open repair is recommended as the first treatment option, especially for athletes and active patients. Various techniques have been described, including end-to-end repair by Bunnell and Kessler. Different techniques have been developed such as the use of fascia grafts to strengthen sutures, the use

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of the plantaris tendon, or peroneal or tibial muscles as graft, and the use of plastic tendon vascular graft. Following ruptures of the rotator sheath and quadriceps tendon, the Achilles tendon is the third most commonly ruptured tendon^{5,7}. Approximately 83% of tears occur during sporting activity and they are seen more frequently in males. The majority of patients are males aged 30-40 years who have a sedentary occupation and occasionally participate in sports³.

The aim of this study was to objectively and subjectively evaluate the treatment results of surgery performed due to acute Achilles tendon rupture together with isokinetic muscle strength measurements.

PATIENTS and METHOD

The study included 35 patients who underwent surgery for Achilles tendon rupture in the Orthopaedics and Traumatology Department of 19 May University Medical Faculty Hospital. The patients included were those who were operated on within at least 15 days of the rupture, and had no history of major trauma or neurological deficits in the contralateral lower extremity, and no osteoarthritic problems in the joints of the operated side. Patients with delayed or bilateral Achilles tendon rupture, rheumatoid diseases, history of long-term drug use (steroid and fluoroquinolone group antibiotics), or neurological deficits on the operated side were excluded from the study. The diagnosis of Achilles tendon rupture was made from physical examination findings and imaging methods such as ultrasonography (USG) or magnetic resonance imaging (MRI). A total of 25 patients with a sufficient follow-up period were evaluated with the scoring system developed by Thermann et al., and with the American Orthopaedic Foot and Ankle Society (AOFAS) scoring system.

Isokinetic muscle strength measurements were performed with the Cybex isokinetic dynamometer (Cybex Human Norm Testing and Rehabilitation System, CSMI Medical Solutions, Stoughton, MA, USA). Power and strength measurements were taken at speeds of 30° and 120°/sec with the patient positioned prone with the hips and knees in full extension (Figures 1). Before the evaluations, each patient had a warm-up session of 10 mins on a static exercise bicycle (Profitness 8350R). The procedure was first applied to the non-operated side. In the evaluation, strength was measured as total work (torque x length) and force as peak torque (force x length).



Figure 1. Isokinetic muscle strength measurement

The statistical data were obtained of 30° and 120°/sec dorsiflexion and plantar flexion peak torque and total work values and the calf circumference measurements. All the data of the patients were compared between the operated and non-operated sides.

The study was approved by the local Ondokuz Mayıs University Clinical Researchs Ethics Committee (Date: 2014, Decision Number:

915). In this retrospective study, all procedures and practices are in accordance with the ethical standards of the national/ institutional research committee and the 1964 Helsinki declaration.

Statistical Analysis

The data obtained in the study were analyzed statistically using SPSS software (SPSS Inc., Chicago, IL, USA). Descriptive statistics were presented as number (n) and percentage (%). In the comparisons of groups of data showing normal distribution, the Student's t-test was applied, and the Mann Whitney U-test was used for data not showing normal distribution. A value of $p < 0.05$ was accepted as statistically significant.

RESULTS

Evaluation was made of 25 patients with acute Achilles tendon rupture, comprising 23 (92%) males and 2 (8%) females with a mean age of 43.5 ± 11.2 years (range, 16-66 years). The rupture was in the right side extremity of 9 (36%) patients and the left side of 16 (64%). The dominant extremity was affected in 7 (28%) patients.

In the evaluation of the mechanism of rupture, it was determined to have occurred while playing football on an artificial pitch in 18 (76%) cases, while playing volleyball in 3 (12%), and during high tempo walking in 4 (16%) (Table 1). Surgery was performed at mean 3.5 ± 3.9 days after surgery (range, 1-15 days). The mean postoperative follow-up period was 36.5 ± 27.5 months (range, 6-96 months). During follow up, superficial skin infection developed in 1 patient, which was successfully treated in 1 week with wound care and oral antibiotherapy. No complications such as skin necrosis, hypertrophic scar tissue, deep vein thrombosis, re-rupture, or sensory defects developed in any patient.

The patients included in the study were evaluated with the AOFAS foot and hindfoot evaluation scores, the post-Achilles tendon surgery scoring system developed by Thermann et al., and the data obtained from the Cybex isokinetic dynamometer.

In the AOFAS foot and hindfoot evaluation scale, pain is evaluated from a total of 40 points, function from 50 points and alignment from 10 points. The mean score of the patients according to this scale was 98.4 ± 3.7 (range, 90-100). Occasional pain at a mild level was reported by 4 (16%) patients and the other 19 patients had no complaints of pain. No restriction in daily activities or need for support was reported by any patient. No alignment defect was determined between the ankle and hindfoot in any patient.

In the Thermann et al. scoring system, objective and subjective parameters are evaluated and the scores are interpreted as 90-100 points excellent, 80-89 points good, 70-79 points moderate, and 60-69 points poor. The mean score of the patients in this scale was 89.2 ± 6.8 points (range, 74-100), interpreted as excellent in 13 (52%) cases, good in 11 (44%), and moderate in 1 (4%). In the objective evaluations, comparison was made with the non-operated side of the values of of ankle range of movement, calf circumference, the one-leg heel raise test, the Thompson test and the isokinetic strength difference measurements.

Calf circumference was measured 10 cm distal of the tibial tuberosity, as mean 39.8 ± 3.4 cm (range 31.5-45.5 cm) on the healthy non-operated side, and 38.8 ± 3.7 cm (range, 29.5-43.5 cm) on the operated side. The difference between the calf circumference measurements of the two extremities was mean 0.9 ± 0.9 cm (range, 0-4.5 cm) and was not statistically significant ($p > 0.05$).

In the comparisons of joint range of movement, a loss of 5° dorsiflexion on the operated side was determined in 2 patients. All patients fully completed the one-leg heel raise test, and the Thompson test was positive.

In the subjective evaluation, for which the patients were requested

to rate the treatment received as excellent, good, moderate, or poor, 21 (84%) cases were evaluated as excellent, 3 (12%) as good, and 1 (4%) as moderate. The patients were questioned about their level of sports participation compared to the pre-injury period. No difference was reported by 12 (48%) patients, minimal loss by 12 (48%) and a decrease by 1 (4%).

In the isokinetic muscle strength measurements, 30° and 120°/sec dorsiflexion and plantar flexion peak torque and total work values were obtained with the Cybex isokinetic dynamometer, and the data

were compared between the two sides. No statistically significant difference was determined between the operated and non-operated sides in respect of the 30° dorsiflexion and plantar flexion peak torque, 120°/sec plantar flexion peak torque and total work values ($p>0.05$). The 120°/sec dorsiflexion peak torque values were found to be statistically significantly higher in the operated ankle than on the non-operated side ($p<0.05$). Isokinetic muscle strength measurement data of one of our patients are shown in Table 1.

Table 1. Cybex isokinetic muscle strength measurement data of one of our patients

Name:	F.A		ID:					Right/Left:
Birth date:	24.06.1982		Involved Side:	Left		Group 1:		
Height:	184 Centimeters		Preferred Side:	Right		Group 2:		
Weight:	95 Kilograms		Doctor:					
Sex:	Male		Tester:					
Diagnosis:								
Surgery:								
Torque Curves	Position Curves							
Isokinetic Con/Con	Plantarflexors (Con)			Dorsiflexors (Con)				
Speed 30/30 deg/sec Reps 5	Value	Cof Var	%BW	Value	Cof Var	%BW	Ratio	
Peak Torque (Newton-Meters - Average Value)								
Right	62	0,16	66	45	0,05	48	72	
Left	65	0,10	69	42	0,09	45	65	
Deficit	-4		6					
Work per Repetition (Newton-Meters - Average Value)								
Right	22	0,20	24	19	0,08	21	88	
Left	22	0,10	24	18	0,15	18	81	
Deficit	0		7					
Range of Motion (Degrees)								
Right	15	0,10		-17	0,00			
Left	15	0,08		-18	0,00			
Isokinetic Con/Con	Plantarflexors (Con)			Dorsiflexors (Con)				
Speed 120/120 deg/sec Reps 15	Value	Cof Var	%BW	Value	Cof Var	%BW	Ratio	
Initial Peak Torque (Newton-Meters - Average Value)								
Right	26	0,00	27	22	0,00	24	84	
Left	24	0,00	27	23	0,00	24	94	
Deficit	5		-6					
Fatigue Index								
Right	42	0,00		6	0,00			
Left	23	0,00		10	0,00			
Total Work Done (Newton-Meters)								
Right	126	0,00	131	144	0,00	152	114	
Left	142	0,00	149	142	0,00	149	100	

DISCUSSION

No consensus on the treatment method for Achilles tendon rupture has been reached as yet. Conservative methods, open surgery and closed surgery methods are used in treatment. As there is no single treatment protocol on which there is large-scale agreement, the approach to Achilles tendon tears is still determined by the surgeon and patient^{3, 8}. Whichever treatment protocol is selected, it should provide a return to work for the patient in the shortest time possible thereby minimizing workforce loss, and minimal complications.

Although there are still surgeons who advocate conservative treatment, operative methods have been preferred in the last two decades, especially for athletes, young adults, and patients with delayed Achilles tendon tear. The treatment to be applied should be

determined according to the patient's age, functional capacity, expectations, and comorbidities. However, the open surgery method is accepted as the best option for active, young patients who want to have an early return to daily and sporting activity⁹. In this respect, open surgery was recommended for the patients who constituted this study group.

The main aim of surgical intervention is to obtain regular apposition of the torn tendon ends, which can usually be successfully achieved with end-to-end sutures. The techniques for this seen to have been used most in literature are the Kessler, Bunnell and Krackow (locking loop) techniques¹⁰⁻¹². All three of these techniques were used in the current study patients, but the low number of cases prevented comparison of the techniques, which could be considered a limitation of the study.

Complications developing after treatment for Achilles tendon tear are generally grouped as major and minor. Major complications are defined as deep vein thrombosis, pulmonary embolism, re-rupture, and serious wound problems (deep infection, wound separation, skin necrosis) and minor complications are defined as superficial wound infection, skin adhesions, and sensory problems associated with sural nerve damage¹³. In a prospective, randomised study by Cetti et al.¹⁴, surgery was applied to 56 patients, and conservative treatment to 45 patients. The re-rupture rates were reported as 5% and 15%, respectively. In the same study, the mean complication (major and minor) rates were found to be 9% in the surgical group and 16% in the conservative treatment group, and excessive lengthening in the tendon was determined in 2.6% of the conservative group patients¹⁴. The same authors conducted a literature scan of 4597 patients and calculated the re-rupture rates as 1.4% after surgical treatment and 13.4% after conservative treatment¹⁴. In the current study, no re-rupture occurred in any patient, and none of the above-mentioned major complications developed.

The location of the skin incision has sometimes been a subject of discussion because of the complications that can develop after surgical treatment of Achilles tendon tears¹⁵. Longitudinal skin incisions of varying lengths are used most. However, good results with a low complication rate have been reported to have been obtained with transverse incisions¹⁶. There is a general tendency to prefer shorter skin incisions located medial to the tendon because sural nerve injuries following lateral incisions and wound problems following wide incisions have often been reported. Garden et al.¹⁷ reported wound site complications at the rate of 17% as a result of open surgical repair, and Naim et al.¹⁸ reported this rate as 20%. In the current study patient group, a medial longitudinal incision was used for all patients and no complications developed such as skin necrosis, hypertrophic scar tissue or sensory defect. In one case, superficial wound site infection was observed and this was successfully treated in one week with oral antibiotherapy and wound care.

Ankle plantar and dorsiflexion strength is one of the important parameters focused on after Achilles tendon tear, and is an objective evaluation of treatment success. The method most used in studies for this evaluation is isokinetic muscle strength measurement. In a series of 66 patients, Bevoni et al.⁹ determined no difference in isokinetic muscle strength between the operated and non-operated sides. In another study by David et al.¹⁹, isokinetic evaluation was made of 40 runners who underwent surgery for acute Achilles tendon tear, and the plantar flexion peak torque value and total work value were reported to be better in the healthy non-operated side. In the current study, no statistically significant difference was determined between the two sides in respect of the plantar flexion peak torque values and the total work values in the isokinetic evaluations.

While plantar flexion values have often been reported in isokinetic measurements, few comparisons have been made in respect of dorsiflexion strength. In a study evaluating surgical and conservative methods, Nistor et al.²⁰ reported higher values of dorsiflexion strength on the affected side in both groups. In the current study, in parallel with the above-mentioned study, dorsiflexion strength was found to be higher on the operated side in the 120°/sec measurements.

In the other parameters used in the current study, the mean AOFAS score was determined as 98.4±3.7, and in the Thermann et al.²¹ scoring system, the mean value was 89.2±6.8. Of the previous studies reporting the results of surgical treatment, the mean AOFAS score was reported as 93.9 by Bevoni et al.⁹, 92.5 by Özsoy et al.²², and 97.7 by Keller et al.²³.

In accordance with literature, calf circumference measurement was considered to be a good parameter in the current study in the follow up of Achilles tendon tear treatment²⁴. The calf circumference was measured of all the patients and compared between the two

extremities. The non-operated side was found to be mean 0.9±0.9 cm thicker but the difference between the two sides was not statistically significant. While Özsoy et al.,²² determined no difference in calf circumference measurements following surgical treatment, Rosso et al.²⁴ determined mean 1.5 cm thinning in patients applied with open surgery.

Achilles tendon rupture is a frequently encountered problem in the middle-aged, active male population. Although there is no definitive evidence for the treatment protocol to be selected, when the patient profile is taken into consideration, the method selected should allow early active movement, shorten the immobilization period, reduce workforce loss to a minimum, have a low complication rate, and increase patient satisfaction. When evaluated in this respect, open surgical repair performed in accordance with surgical principles and rules, can be considered a preferable treatment method for Achilles tendon rupture. As no consensus has yet been reached on this subject, there is a need for further comparative studies of larger case series, which will contribute to the existing literature.

A limitation of this study was that the surgical techniques could not be statistically compared because of the low number of cases.

Conclusion

The results of this study showed that as a result of surgery applied to the patient group there was no loss of plantar flexion strength and there was an increase in dorsiflexion strength on the operated side. To be able to explain this increase in dorsiflexion strength, further studies are required with larger patient series.

As no consensus has yet been reached on this subject, there is a need for further comparative studies of larger case series, which will contribute to the existing literature.

Conflicts of interest statement

The authors declare no conflicts of interest.

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