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Comparison Between Early Functional Rehabilitation and Cast Immobilization After Minimally Invasive Repair for an Acute Achilles Tendon Rupture

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ABSTRACT

The purpose of the present study was to compare the outcomes of patients with Achilles tendon rupture treated with minimally invasive repair and early functional rehabilitation with the outcomes of similar patients treated with cast immobilization. After undergoing minimally invasive surgery, a below-knee splint with the foot in 30° of plantarflexion was applied to each patient for the first week. Patients were then assigned to a cast immobilization group (IG; n = 25) or a functional group (FG; n = 16). Data were collected during outpatient checks at 6 weeks, 3 months, 6 months, and 1 year. Outcomes of interest included range of motion (ROM), heel height, calf circumference, pain and functional score, return to work and light sports activity, and complications. The time interval for return to work in the FG was faster than that in the IG ($p = .026$). There was no clinically important difference between the 2 groups with regard to heel height, ROM, return to sports, calf circumference, visual analog scale, American Orthopaedic Foot and Ankle Society score, or Achilles tendon Total Rupture Score at every outpatient check except ROM difference at 6 weeks and heel height at 3 months. Rerupture occurred in 2 patients (1 [4%] in the IG and 1 [6.25%] in the FG). Early functional rehabilitation seemed to be as safe as traditional postoperative immobilization with a similar functional result and complications, but it was advantageous for the early phase of rehabilitation only.

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Although the Achilles tendon (AT) is the largest and strongest tendon, it is often prone to ruptures (1). The incidence of AT rupture (ATR) has been on the rise since the 1980s (2,3). Despite increasing incidence of ATR, there is no consensus regarding the optimal postoperative management for acute ATR (4–7). After operation, it is important for the patient to undergo rehabilitation to minimize dysfunction and optimize return to preinjury activities. Early weightbearing combined with early ankle motion exercises can achieve a superior and more rapid functional recovery than conventional immobilization after surgical repair of acute ATR (8–13). Many studies have reported that early functional rehabilitation after open surgery has benefit (10,14); however, there is no comparison study about rehabilitation after minimal invasive surgery. The objective of this study was therefore to compare the outcomes of patients with acute ATR treated with minimally invasive repair and early functional rehabilitation with the outcomes of similar patients treated with cast immobilization.

Patients and Methods

This retrospective study was approved by the institutional review board of the Ajou University Hospital (AJIRB-MED-MDB-15-378). Between May 2013 and August 2014, a total of 69 patients (69 feet) underwent AT repair for acute ATR by 1 surgeon (Y.U.P.). All patients were primarily diagnosed with acute ATR based on history and physical examinations. The diagnosis was verified with ultrasound. A total of 28 (40.6%) patients were excluded from this study because of open repair (18 [26.1%] patients), short follow-up period (<1 year, 3 [4.3%] patients), chronic tear (5 [7.2%] patients), or distal tear (2 [2.9%] patients). The remaining 41 [59.4%] patients who underwent minimally invasive AT repair were included in this study.

Operative Technique

All 28 patients were operated on under regional anesthesia in the prone position with a thigh tourniquet and slight knee flexion to relax the gastrocnemius muscles. A posteromedial longitudinal incision of 2 to 2.5 cm was made over the area of the rupture located by palpation. The paratenon was incised and preserved.

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Following removal of the underlying hematoma, both tendon stumps were identified. If the rupture was somewhat oblique as opposed to strictly transverse, the incision was extended proximally or distally for better exposure and for later stump adaptation or suture. The patients who underwent open repair for this reason were excluded from this study.

A reusable metal PARS jig (Arthrex, Naples, FL) was inserted into the tendon sheath, and 3 different colored no. 2 Ethibond (Ethicon, Somerville, NJ) sutures were inserted percutaneously into each end of the tendon using needles, followed by suture passing, leaving 3 nonlocked sutures in each end. The tendon ends were gently pushed down into the central aspect of the jig by hand during suture insertion. An assistant held the foot with a plantarflexion of 10° superior to the healthy side that was freely hanging at the end of the table. The threads were knotted at the site of the rupture with a tension that left the ankle with a spontaneous plantarflexion of 10° superior to the healthy foot when it was left hanging as described in Rippstein's method (7). The paratenon was closed with 3-0 Vicryl (Ethicon) sutures. Subcutaneous tissues were closed with 3-0 Vicryl sutures. Skin was closed with 3-0 nylon suture. Before the patient woke up from the anesthesia and was moved from the operating table, the leg was secured in a splint with 30° plantarflexion at the ankle.

Grouping and Rehabilitation

At 1 week after operation, patients returned to the outpatient clinic, where the rehabilitation method was decided. Rehabilitation protocol consisted of functional treatment as early mobilization and early weightbearing or immobilization as serial casting. All patients gave informed consent about the advantages and disadvantages of the 2 rehabilitation protocols. They chose 1 of the 2 methods after discussing the options with a surgeon, the choice being completely at the discretion of the patient.

The ankle in the immobilization group (IG) was immobilized in a fiberglass cast in 110° of flexion for an additional week, 100° for the next week, and a neutral position the next week with non-weightbearing. Four weeks after surgery, patients were transitioned into a tall boot with progression of weightbearing. Physical therapy was started at 4 weeks after operation with range of motion (ROM) and nonimpact strengthening exercises. At 6 weeks, patients were informed to do double heel rise exercises and stretching. At 8 to 12 weeks, patients were weaned out of the controlled ankle motion boot into regular athletic shoes with weightbearing if it could be tolerated. From 12 to 16 weeks, activity level was increased without competitive running or jumping until 16 weeks after operation.

Patients in the functional group (FG) were transitioned into the same kind of controlled ankle motion boot and started with 3 peel-away heel lifts with progression of weightbearing at 1 week after operation. The heel lifts were removed weekly 1 by 1 from the ankle in 20° equinus at 1 week to neutral at 4 weeks after operation. Dorsiflexion-limited ROM exercises were allowed from 1 week after operation. Physical therapy was started at 4 weeks after operation with ROM and nonimpact strengthening exercises. The rest of rehabilitation protocol was identical to that of IG.

Baseline comparisons of the 2 groups are depicted, along with outcomes, in the Table. The IG included 25 patients (25 feet), including 21 (84%) men and 4 (16%) women, with an average age of 39.3 (range 26 to 50) years. The mean follow-up period was 14 (range 12 to 23) months. The FG included 16 patients (16 feet) consisting of 14 (87.5%) men and 2 (12.5%) women, with an average age of 37.7 (range 19 to 52) years. The mean follow-up period was 14 (range 12 to 23) months.

Outcome Measures and Statistics

Patients were reviewed postoperatively at 6 weeks, 3 months, 6 months, and 1 year. All clinic notes, operative dictations, and physical therapy evaluations were reviewed. The primary outcome was the time of return to work and time of return to light sports activity. Time of return to work and time of return to light sports activity, such as rapid walking and jogging, were recorded. Secondary outcomes included calf circumference and heel rise height when a single heel was raised for calf muscle recovery in addition to ROM for recovery of flexibility. For subjective pain scale and functional status, the visual analog scale (VAS) pain score, American Orthopaedic Foot and Ankle Society (AOFAS) hindfoot score, and Achilles tendon Total Rupture Score (ATRS) were reviewed (15,16).

Calf circumference was measured 10 cm distal to the tibial tubercle and compared with that of the opposite side. To determine limitations in ROM, active dorsi- and plantarflexion were measured with a handheld goniometer and compared with those of the opposite leg. The heel rise height was measured as a distance from ground to the heel when patients lifted the heel at least 2 cm while keeping the knee straight. Patients standing with 1 foot on the ground were instructed to perform heel rise. They were permitted to have 3 fingertips per hand against the wall for balance. They were instructed to go as high as possible on each heel rise and then lower the heel to the ground. The ATRS is a patient-reported instrument for measuring outcome. It is related to symptoms and physical activity after treatment for total ATR. Problems with wound healing or rerupture and symptoms of sural nerve injury were noted.

All data were collected in our outpatient clinic by 1 of the authors. Statistical significance was considered with $p \leq .05$ (the 5% level). Continuous data such as ROM, time of return to sports and work, heel height, calf circumference, and numeric scales (VAS, AOFAS, ATRS) were compared using the Mann-Whitney test.

Results

Time to Return to Work and Sports

The mean time to return to work was 26.3 ± 20.2 days in the FG and 39.9 ± 25.0 days in the IG ($p = .026$). Patients' work included their previous occupation and alternative temporary work. The mean time to return to sports was 126.8 ± 49.9 days in the FG and 141.4 ± 74.7 days in the IG ($p = .57$). Light sports activity included rapid walking and jogging.

Six Weeks After Operation

At 6 weeks after operation, the mean calf circumference of the FG was 35.5 ± 3.1 cm and 35.8 ± 1.6 cm for the IG ($p = .804$). The mean heel height during single heel rise was 0.36 ± 0.93 cm in the FG and 0.40 ± 1.12 cm in the IG ($p = .965$). The mean difference in ankle ROM was 2.0° ± 4.1° in the FG and 12.0° ± 7.6° in the IG ($p < .001$). The mean VAS pain score was 0.93 ± 1.27 in the FG and 0.84 ± 1.21 in the IG ($p = .868$). The mean AOFAS hind foot score was 73.5 ± 8.9 in the FG and 70.3 ± 9.5 in the IG ($p = .292$). The mean ATRS was 66.9 ± 16.1 in the FG and 73.1 ± 11.3 in the IG ($p = .267$). There was no significant ($p > .05$) difference in any variable between the 2 groups except ROM at 6 weeks after operation (Table).

Three Months After Operation

At 3 months after operation, the mean calf circumference was 36.7 ± 2.2 cm in the FG and 36.2 ± 3.6 cm in the IG ($p = .825$). The mean heel height during single heel rise was 8.80 ± 2.42 cm in the FG and 5.16 ±

Table
Clinical data of patients in the functional and and immobilization groups

Variables	FG (n = 16)	IG (n = 25)	*p* Value
Age, y	37.7 ± 6.64 (range 19 to 52)	39.3 ± 7.46 (range 26 to 50)	.748
Sex, M (%), F (%)	14 (87.5), 2 (12.5)	21 (84), 4 (16)	.096
6 wk			
Calf circumference, cm	35.5 ± 3.1	35.8 ± 1.6	.804
Heel height, cm	0.36 ± 0.93	0.40 ± 1.12	.965
ROM difference, °	2.0 ± 4.1	12.0 ± 7.6	<.001
VAS pain	0.93 ± 1.27	0.84 ± 1.21	.868
AOFAS hindfoot score	73.5 ± 8.9	70.3 ± 9.5	.292
ATRS	66.9 ± 16.1	73.1 ± 11.3	.267
3 mo			
Calf circumference, cm	36.7 ± 2.2	36.7 ± 3.6	.825
Heel height, cm	8.80 ± 2.42	5.16 ± 3.41	.001
ROM difference, °	0	0	
VAS pain	0.86 ± 1.41	0.80 ± 1.04	.912
AOFAS hindfoot score	88.3 ± 10.1	89.1 ± 6.7	.956
ATRS	49.5 ± 13.5	51.6 ± 13.9	.619
6 mo			
Calf circumference, cm	37.2 ± 1.9	37.4 ± 3.6	.699
Heel height, cm	11.40 ± 1.64	10.60 ± 1.94	.255
ROM difference, °	0	0	
VAS pain	0.46 ± 1.13	0.44 ± 0.96	1.000
AOFAS hindfoot score	92.7 ± 5.8	92.7 ± 4.8	.659
ATRS	24.9 ± 11.4	23.4 ± 10.3	.804
1 y			
Calf circumference, cm	38.3 ± 2.1	38.3 ± 3.8	.934
Heel height, cm	12.23 ± 1.96	12.08 ± 1.38	.716
ROM difference, °	0	0	
VAS pain	0.40 ± 1.12	0.44 ± 1.12	.783
AOFAS hindfoot score	92.7 ± 8.4	92.7 ± 8.3	.507
ATRS	9.7 ± 3.9	10.6 ± 13.8	.222
Follow-up, mo	14.3 ± 2.6	14.5 ± 3.1	.915

Abbreviations: AOFAS, American Orthopaedic Foot and Ankle Society; ATRS, Achilles tendon Total Rupture Score; FG, functional group; IG, immobilization group; ROM, range of motion; VAS, visual analog scale.
Data presented as n ± standard deviation unless otherwise noted.

3.41 cm in the IG ($p = .001$). The mean difference in ROM of the ankle was 0 in both groups. The mean VAS pain score was 0.86 ± 1.41 in the FG and 0.80 ± 1.04 in the IG ($p = .912$). The mean AOFAS hind foot score was 88.3 ± 10.1 in the FG and 89.1 ± 6.7 in the IG ($p = .956$). The mean ATRS was 49.5 ± 13.5 in the FG and 51.6 ± 13.9 in the IG ($p = .619$). There was no significant ($p > .05$) difference in any variable between the 2 groups except heel height at 3 months after operation.

Six Months After Operation

At 6 months after operation, the mean calf circumference was 37.2 ± 1.9 cm in the FG and 37.4 ± 3.6 cm in the IG ($p = .699$). The mean heel height during single heel rise was 11.40 ± 1.64 cm in the FG and 10.60 ± 1.94 cm in the IG ($p = .255$). The mean difference in ROM of the ankle was 0 in both groups. The mean VAS pain score was 0.46 ± 1.13 in the FG and 0.44 ± 0.96 in the IG ($p = 1.000$). The mean AOFAS hind foot score was 92.7 ± 5.8 in the FG and 92.7 ± 4.8 in the IG ($p = .659$). The mean ATRS was 24.9 ± 11.4 in the FG and 23.4 ± 10.3 in the IG ($p = .804$). There was no significant ($p > .05$) difference in any variable between the 2 groups.

One Year After Operation

At 1 year after operation, the mean calf circumference was 38.3 ± 2.1 cm in the FG and 38.3 ± 3.8 cm in the IG ($p = .934$). The mean heel height during single heel rise was 12.23 ± 1.96 cm in the FG and 12.08 ± 1.38 cm in the IG ($p = .716$). The mean difference in ROM of the ankle was 0 in both groups. The mean VAS pain score was 0.40 ± 1.12 in the FG and 0.44 ± 1.12 in the IG ($p = .783$). The mean AOFAS hind foot score was 92.7 ± 8.4 in the FG and 92.7 ± 8.3 in the IG ($p = .507$). The mean ATRS was 9.7 ± 3.9 in the FG and 10.6 ± 13.8 in the IG ($p = .222$). There was no significant ($p > .05$) difference in any variable between the 2 groups.

Complications

There were 2 (12.5%) complications in the FG and 1 (4%) in the IG. One (6.3%) superficial infection occurred in the FG; however, it improved without any problem. There were 2 (6.3% in the FG, 4% in the IG) patients with rerupture (1 case in each group). They were diagnosed at 2 weeks and 10 weeks after operation, respectively. One (6.3%) patient in the FG sustained a rerupture during a fall on level ground 2 weeks after operation. The other patient (4%) in the IG sustained a rerupture when walking on an unpaved road.

Discussion

Early introduction of an active rehabilitation program described in this series of patients appeared to provide a rapid return to social and occupational activities. The time interval for return to work was dependent on several factors, including the type of work required (i.e., laboring versus sedentary office work). An average of 26 days for return to work reported in the FG was more favorable compared with the 40 weeks reported in the IG. In addition, ROM at 6 weeks and heel height at 3 months were significantly different between the 2 groups. Our study showed a favorable result of early weightbearing and mobilization, especially at 3 months after operation (i.e., early phase of rehabilitation).

Early ROM and controlled loading of healing tendons have been shown to result in improved healing and outcomes in animal models and some human studies (3,17–20). Maffulli et al (21) reported that patients in the early weightbearing group need less physiotherapy. They discontinued use of crutches at an average of 2.5 weeks earlier based on a randomized comparison study between casting with immediate weightbearing and casting with no weightbearing for the first 4 weeks postoperatively. Costa et al (17) compared the outcome following immediate mobilization and weightbearing in a carbon-fiber orthosis and the outcome of traditional plaster cast immobilization and non-weightbearing. For patients treated operatively, those with mobilization and early weightbearing showed significantly improved early functional outcomes compared with other groups. Other studies have compared the outcomes of patients treated with weightbearing at 2 weeks after surgical repair with the outcomes of patients treated with the traditional 4 to 6 weeks without weightbearing and found similar advantages for early mobilization (19,20,22).

Groetelaers et al (10) stated that there was no difference in strength, quality of life scores, return to work or sports, or functional score between the FG and IG in their prospective study for functional treatment or cast immobilization after minimally invasive repair of an acute ATR. In agreement with other investigations, however, our study showed a favorable result of early weightbearing and early mobilization.

We expected not only early return to work and early recovery of ROM and heel height but also to see faster return to sports and faster recovery during the late phase of rehabilitation in the FG; however, there was no difference in the time interval of return to light sports activity. In addition, there was no clinically significant difference with regard to heel height, ROM, calf circumference, VAS, AOFAS, or ATRS at 6 months or 1 year; therefore, early functional rehabilitation might not have positive effect on long-term (>6 months) outcomes.

There were 2 patients with rerupture (1 in each group). One patient in the FG sustained a rerupture during a fall on level ground 2 weeks after operation. He was treated with open surgical repair again. The other patient in the IG sustained a rerupture when walking on an unpaved road. He was treated with conservative cast immobilization for an additional 6 weeks. These patients eventually recovered without any other complications. In both groups, there was 1 patient with superficial infection of a proximal wound that was treated conservatively with antibiotics and local wound therapy.

Minimally invasive techniques are notorious for causing damage to nerves (i.e., the sural nerve); therefore, this issue received specific attention in our study population. Although we did not observe any symptoms of nerve damage in any patient, sural nerve injury has been reported to occur in 9% to 18% of percutaneous Achilles repair cases (23,24). There was no deep vein thrombosis or deep tissue infection in this study. Our overall complication rate of 7.3% was lower than that in previous limited incision Achilles repair studies (25–27). Metz et al (28) reported a 36% overall complication rate after minimally invasive Achilles repair.

There are some limitations in the present study. First, it was a retrospective study. Second, it had a small number of patients. In addition, surgeons chose which rehabilitation method to perform based on individual preference rather than randomization. This might have added potential bias to perform rehabilitation.

In conclusion, the minimally invasive repair of ATR was a safe and reliable technique with good results. Early mobilization and weightbearing seemed to be as safe as traditional postoperative immobilization. It achieved a more rapid functional recovery than conventional immobilization after minimally invasive surgical repair of acute ATRs, especially sooner than 3 months after operation.

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