Acute Achilles Tendon Ruptures: A Comparison of Minimally Invasive and Open Approach Repairs Followed by Early Rehabilitation

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Abstract

We retrospectively compared the outcomes of early functional weight-bearing after use of 2 different approaches (minimally invasive, standard) for surgical repair of the Achilles tendon. We reviewed the cases of 63 consecutive patients who underwent repair of an acute closed Achilles tendon rupture and had follow-up of at least 6 months.

Of these 63 patients, 33 were treated with a minimally invasive posterolateral approach (minimal group), and 30 were treated with a standard posteromedial approach (standard group). Two weeks after surgery, each patient was allowed to weight-bear as tolerated in a controlled ankle movement boot with a 20° heel wedge. At 6 weeks, the patient was placed in a regular shoe with a heel lift. We examined range of motion and incidence of reruptures, sural nerve injuries, and wound complications at 6 weeks and 3 months and calf strength at 6 months.

Neither group had any reruptures. Mean incision length was 2.5 cm (minimal group) and 7.2 cm (standard group). One patient (3.2%) in the minimal group and 6 patients (20%) in the standard group developed a superficial wound infection. Four (12.9%) of 31 minimal patients and no standard patients developed a sural nerve deficit. There were statistically significant differences between the groups' wound complication rates ($P = .04$) and nerve injury rates ($P = .043$). At final follow-up, the groups did not differ in their functional outcomes (ability to perform a single heel raise, American Orthopaedic Foot and Ankle Society scores).

Used after a minimally invasive posterolateral or standard posteromedial approach, early functional weight-bearing is an effective and safe method for treating acute ruptures of the Achilles tendon, and it has a lower rate of soft-tissue complications. A standard posteromedial approach has a higher rate of wound complications, and a minimally invasive posterolateral approach has a higher rate of sural nerve injury.

Achilles tendon pathology is a common problem, especially in adults in the third to fifth decade of life.[1] Most commonly, acute Achilles tendon ruptures are treated with surgical repair, and nonoperative treatment is reserved for older, sedentary patients. Surgical repair has been shown to have a complication rate higher than that of nonsurgical treatment.[2,3] The multiple repair techniques reported in the literature include a standard posteromedial approach, a minimally invasive approach, and a percutaneous approach.[4,5] Most commonly, the direct open approach uses a 6- to 18-cm posteromedial incision. The minimally invasive approach uses a 2- to 6-cm incision, and the percutaneous approach involves repairing the tendon through multiple small incisions. Most studies comparing the different types of approaches show similar rates of complications and outcomes.[6,7]

According to a literature review[8] multiple postsurgical rehabilitation protocols have been advocated. These range from keeping the patient non–weight-bearing for 6 to 8 weeks to immediate mobilization with early weight-bearing.[9,10] Recent studies have shown that early rehabilitation after repair of the Achilles tendon has benefits that include increased tendon elongation in patients immobilized after surgery compared with patients who underwent early motion.[9-12] A rat study showed that early physical activity increased the speed of healing of the Achilles tendon after acute rupture.[13] Early weight-bearing after surgical repair showed a trend of decreasing the number of workdays lost and a faster return to sports.[11]

We retrospectively compared the outcomes of early func-

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Table 1. Demographics of the 2 Groups

Group	No. of Patients	No. of Men	No. of Women	Mean Age, y	Mean Follow-Up, mo
A	33	31	2	34.2[a]	21
B	30	26	4	43.2[a]	43

[a]*P* = .0016 (significant).

tional weight-bearing after use of 2 different approaches (minimally invasive, standard) for surgical repair of the Achilles tendon. We hypothesized there would be a significant difference in the rate of wound complications, but the other outcomes would not differ significantly between the 2 groups.

Materials and Methods

Patient Selection

We retrospectively and prospectively reviewed the cases of 63 consecutive patients who underwent Achilles tendon repair using either a minimally invasive posterolateral approach (group A) or a standard posteromedial approach (group B) at our institution between 2006 and 2010 (**Table 1**). Exclusion criteria included open ruptures, ruptures older than 3 weeks, and age under 18 years. One surgeon performed the standard posteromedial approach, and another performed the minimally invasive posterolateral approach. After surgery, all patients were treated with an accelerated rehabilitation protocol.

Surgical Technique

In the minimally invasive approach, the patient is placed in a lateral decubitus position, and a tourniquet is applied to the thigh. Typically a 2- to 4-cm posterolateral incision is made centered over the defect in the tendon. The sural nerve is identified and protected. The paratenon is incised to expose the ruptured tendon ends. The repair is performed with the Bunnell suture technique using nonabsorbable suture to approximate the tendon ends. A braided absorbable suture is then used to augment the repair. The ankle is dorsiflexed to neutral to assess if the repair is placed under tension. The paratenon is repaired with a braided absorbable suture. The patient is placed in a short leg splint in approximately 10° of equinus.

In the standard approach, the patient is placed in a prone position, and a tourniquet is applied to the thigh. A 6- to 10-cm posteromedial incision is made centered over the rupture in the Achilles tendon. The paratenon is incised longitudinally in line with the skin incision. The repair is performed with a nonabsorbable suture with a Krakow suture technique with 4 strands connecting the tendon stumps. The foot is placed in approximately 10° of plantarflexion, and the sutures are tied. The paratenon is repaired with a braided absorbable suture. After surgery, the patient is placed in a boot with a 30° heel wedge.

Postoperative Rehabilitation

After surgery, the patient is immobilized in a 10° to 20° equinus splint (minimal group) or removable boot with a 30° heel wedge (standard group) for 2 weeks. Immobilization may be extended if there is any concern about wound healing. At 2 weeks, full weight-bearing with a removable boot is permitted in both groups. In the minimal group, the patient's ankle is placed in a boot with a 20° heel wedge. In the standard group, heel wedges are removed at regular intervals until the 6-week follow-up. Patients are encouraged to start active ankle range of motion (ROM) out of the boot. At 6 weeks, patients are prescribed physical therapy, which includes active ankle ROM, stretching exercises, and gait training.

Data Collection and Statistical Analysis

After surgery, the patients were followed up at regular intervals and examined for rerupture, sural nerve injury, wound complications, ROM, and calf strength. Incision length was measured at time of surgery and was documented in the operative report. A goniometer was used to assess passive ankle ROM with the patient sitting on the examination table. ROM was compared between the operated ankle and the contralateral ankle. Calf strength was determined by whether the patient could perform a single heel raise and by muscle strength testing on physical examination. Patients were asked about when they returned to sports or their regular activities. American Orthopaedic Foot and Ankle Society (AOFAS) scores were obtained when the patients were at least 6 months after surgery. All measurements were taken by the attending surgeon, an orthopedic surgery resident, or a dedicated orthopedic research assistant.

Using Student t test, we statistically analyzed the rates of wound complications and nerve palsies; the recorded values of dorsiflexion, plantarflexion, and total arc of motion at 6 weeks and 3 months; the recorded values of calf strength at 3 months and 6 months; and AOFAS scores.

Results

After obtaining institutional review board approval, we retrospectively identified 33 patients in whom the minimally invasive posterolateral approach was used (group A) and 30 patients in whom the standard posteromedial approach was used (group B). Only 1 patient was excluded from the minimally invasive group (the patient moved overseas before reaching 6-month follow-up). Patient age ranged from 24 to 52 years (mean, 34.2 years) in the minimal group and from 22 to 77 years (mean, 43.2 years) in the standard group. There were 2 women in the minimal group and 4 women in the standard group. The groups were comparable on gender, but there was a statistically significant difference in patient age ($P = .0016$). Mean (range) follow-up was 21 (6-60) months in the minimal group and 43 (6-72) months in the standard group (**Table 1**).

The groups' results at final follow-up are detailed in **Table 2**. There were no reruptures in either group. There was a statistically significant ($P = .04$) difference in the groups' wound complication rates. None of the infections required reoperation, and all resolved with local wound care and antibiotic therapy. In the minimal group, 4 patients (12.5%) developed a sural nerve deficit. Three of the 4 deficits resolved completely

by 6 months; the fourth was improved but still present at 6 months. There was a statistically significant (P = .043) difference between the groups' nerve deficit rates.

Postoperative ROM was assessed on physical examination at the 6-week and 3-month follow-ups (**Table 2**).

At 6 months, 23 (72%) of 32 patients in the minimal group could perform a single heel raise without support. The 9 patients unable to perform a single heel raise were tested manually on physical examination. Five of the 9 had 4+/5 strength, and the other 4 had 4/5 strength. Of the 30 patients in the standard group, 16 (53%) could perform a single heel raise without support at 6 months. Of the 14 patients unable to perform a single heel raise, 8 had 4+/5 strength, and 6 had 4/5 strength. Between the groups, there was no statistically significant difference in strength at 6 months (P = .14). Patients reported returning to their usual sports or activities at a mean (range) of 7 (2-18) months in the minimal group and 8.45 (1.5-18) months in the standard group. There was no statistically significant difference between the groups in amount of time to return to driving or sports/activities or in AOFAS scores.

Table 2. **Results of the 2 Groups**

Result	Group A (n = 32)	Group B (n = 30)	*P*
Rerupture, n (%)	0 (0%)	0 (0%)	—
Wound complication, n (%)	1 (3.2%)	6 (20.0%)	.04[a]
Nerve injury, n (%)	4 (12.5%)	0 (0%)	.043[a]
Mean incision length, cm	2.5	7.2	—
6 Weeks			
Mean dorsiflexion	8.9°	2.8°	.0002[a]
Mean plantarflexion	19.0°	26.9°	.011[a]
Mean range of motion	28.0°	30.1°	.52
3 Months			
Mean dorsiflexion	16.5°	13.3°	.021[a]
Mean plantarflexion	29.7°	33.3°	.08
Mean range of motion	46.5°	44.0°	.42
6 Months			
Single heel raise, n (%)	23 (72%)	16 (53%)	.14
Return to driving, wk	3.8	11.75	.17
Return to sports/activities, mo	7	8.45	.52
American Orthopaedic Foot and Ankle Society score	93.3	96.7	.34

[a]Significant.

Discussion

We reviewed 2 groups of patients who underwent early functional rehabilitation but had different surgical approaches and repair methods. Among all patients with at least 6 months of follow-up, there were no reruptures. Given the low incidence of rerupture reported in other studies,[2,14] we would have had to include more patients in both our groups to determine if there were a significant difference in their rerupture rates.

Wound complications occurred in 1 (3.2%) of 32 patients in the minimally invasive group and 6 of 30 (20%) in the standard posterolateral approach group. Our results are comparable to those of Cretnik and colleagues,[15] who compared open and percutaneous repair of the Achilles tendon and reported complication rates of 9.7% for percutaneous repair and 21% for open repair. We found a statistically significant (P = .04) difference in our groups' wound complication rates. The larger number of wound complications in the standard group may be related to the larger incision (mean, 7.2 cm) used for the repair. In this study, all 7 wound complications healed without repeat trips to the operating room or the need for soft-tissue coverage.

Four patients (12.5%) in the minimal group and none of the patients in the standard group developed a sural nerve deficit. Three of the 4 nerve deficits were resolved by 6-month follow-up, and the fourth was improving on physical examination. That 3 of the 4 deficits resolved and the fourth was improving most likely indicates that the nerve had sustained a traction injury during surgery. There was a statistically significant (P = .043) difference in our groups' rates of sural nerve dysfunction. That 12.5% of the patients developed a sural nerve deficit is consistent with findings in other studies. Sutherland and Maffulli[16] reported a 16% incidence of sural nerve deficit in patients with a percutaneously repaired Achilles tendon, and Lansdaal and colleagues[17] reported a 9.2% rate of sural nerve dysfunction in their series of 163 patients who underwent minimally invasive repair. As is routine in our procedure with the minimally invasive posterolateral approach, the sural nerve is identified and protected throughout the case.

At 6-week follow-up, the minimal group had mean ROM of 8.9° dorsiflexion and 19° plantarflexion, and the standard group had mean 2.8° dorsiflexion and 26.9° plantarflexion. Mean arc of motion was 28.0° in the minimal group and 30.1° in the standard group (P = .52). The groups differed significantly in dorsiflexion (P = .0002) and plantarflexion (P = .011) but not in mean arc of motion. This is most likely attributable to the postoperative immobilization used in each group. The increased plantarflexion in the standard group was potentially related to these patients being placed in 30° of equinus immediately after surgery, and the patients in the minimal group being placed in approximately 10° of equinus in a well-molded posterior plaster splint with a stirrup. By 3-month follow-up, only dorsiflexion differed significantly (P = .021) between the groups. Mean plantarflexion (P = .08) and mean arc of motion (P = .42) were not significant. Our groups' ROM was comparable to that reported in other studies with an early postoperative functional regimen.[11,12]

Two methods were used to assess calf strength. At 6-month follow-up, patients are asked to perform a single heel raise using only the examination table for balance. Patients unable to do this were manually tested. Twenty-three (72%) of 32

patients in the minimal group and 16 (53%) of 30 patients in the standard group were able to perform the single heel raise. There was no statistically significant difference in calf strength between the groups. The difference between the groups on the single heel raise may be related to the more extensile incision used in the standard group, the specific rehabilitation protocol prescribed at 6-week follow-up, the younger patients in the minimal group, and the larger number of standard-group patients with wound complications, which may have delayed rehabilitation progress. All patients in this study had manually tested strength of at least 4/5 by 6-month follow-up. In 2008, Suchak and colleagues[11] reported that, by 6-month follow-up, patients had obtained only about 50% endurance in calf muscle strength on the operative side, despite early weight-bearing.

Mean time to return to sports or activities was 7 months in our minimal group. In 1 study, elite athletes' mean time to return to sports was 4.8 months[18]; in 2 other studies, all patients returned to sports by 6 months[9] (mini-open repair) or 25 weeks (limited open repair).[19] Our standard-group patients returned to sports at a mean of 8.45 months. Mean time to return to sports after standard open repair was 13.1 weeks in one study[20] and 7 months in another.[21] Our minimal group's mean AOFAS score was 93.3, consistent with scores reported in other studies using a mini-open or minimally invasive approach.[3,9,22-24] Mean AOFAS score in our standard group was 96.7, also consistent with other reported scores.[3,25] There were no statistically significant differences between our groups with respect to time to return to driving and sports, or AOFAS scores.

Multiple studies have shown an advantage for early functional rehabilitation over immobilization.[4,7-9,11,17,20,21,26-38] The same was true of our study. We compared 2 different surgical approaches but used a similar postoperative early rehabilitation protocol.

Many authors have shown that minimally invasive repair of acute Achilles tendon ruptures is a safe and reliable alternative to standard repair.[4,6,9,15,17,22,39-49] In 2010, Quagliarella and colleagues[49] studied patients who underwent open or minimally invasive repair and a control group of healthy subjects to compare the 2 operative techniques. The patient groups had similar results on a jumping evaluation. In 2007, Lansdaal and colleagues[17] reported on a series of 163 patients who underwent Achilles tendon repair with a minimally invasive approach and postoperative functional rehabilitation. There were only 2 wound infections, and the rate of sural nerve dysfunction was 9.2%. The authors concluded that minimally invasive repair with early functional rehabilitation is safe and has a low complication rate and high patient satisfaction. Ceccarelli and colleagues[6] compared patients who underwent percutaneous Achilles repair or minimally invasive repair and found that the groups were isokinetically similar and had similar functional and clinical outcomes. Although the comparison may not be ideal, as different percutaneous techniques were used, the idea of a minimal or small-incision approach with minimal soft-tissue dissection and early rehabilitation is similar across these studies.

Limitations of the present study include its retrospective nature and relatively small sample size. A prospective randomized trial with identical postoperative rehabilitation protocols would better elicit a difference between the minimally invasive posterolateral approach and the standard posteromedial approach. Given the low incidence of postoperative rerupture reported in the literature,[7,44] the limited number of patients in our groups prevented us from fully evaluating whether a rerupture difference exists between the surgical approaches and their repair methods. Another limitation is observer bias. All patient data were recorded by the surgeon at each postoperative visit, not by an independent trained researcher, and lack of a standardized protocol for the groups may have affected the data (but note that one group's surgeon-specific protocol was similar to the other's).

Conclusion

Our study results demonstrated that both the minimally invasive posterolateral approach and the standard posteromedial approach were effective and safe methods for treating acute ruptures of the Achilles tendon. There were significant differences between the approaches with respect to postoperative dorsiflexion and plantarflexion ankle ROM, but the total arc of motion was similar. There were trends toward a higher wound complication rate in the standard group and toward a higher rate of sural nerve deficits in the minimal group. There was also a trend toward improved outcome (single heel raise at 6 months) in the minimal group compared with the standard group.

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