Favorable Outcome of Percutaneous Repair of Achilles Tendon Ruptures in the Elderly

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Abstract Percutaneous repair of Achilles tendon (AT) ruptures reportedly reduces the risk of rerupture compared to nonoperative treatment and reduces the risk of wound infection compared to open surgery. We retrospectively reviewed the postoperative Achilles tendon total rupture score (ATRS), and the maximum calf circumference in 35 patients over 65 years of age who sustained an acute tear of the AT and underwent percutaneous repair of the AT. There were 26 men and nine women with a mean age at

operation of 73.4 ± 8.7 years (range, 65–86 years). Of the 35 recruited patients, we report on 27 patients for whom we have a full data set. The minimum followup was 49 months (mean, 88 months; range, 49–110 months). The ATRS had a postoperative average rating of 69.4 ± 14 (range, 56–93). All patients were able to bear weight fully on the affected limb by the eighth postoperative week. The data suggest that percutaneous repair of the AT is a suitable option for patients older than 65, producing similar outcomes when compared to percutaneous repair in younger patients of previous reports.

Level of Evidence: Level IV, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

Each author certifies that he or she has no commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

Each author certifies that his or her institution has approved the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained. This work was performed at Keele University School of Medicine, Staffs., England.

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Introduction

The Achilles tendon (AT), the largest and strongest tendon in the human body, is the most frequently ruptured [1, 36]. Acute ruptures of the AT occur most commonly in men in their third and fourth decades of life who participate in sports intermittently [21, 33]. The management of AT ruptures has changed with time, as more evidence is available in favor of early weight bearing and early active mobilization [26, 34, 35], and also for the use of percutaneous techniques instead of open surgery [21, 24]. One review of the literature [20] suggested that most patients were around 40 years old, although the ages ranged from 12 to 86 years. Most reports describe the injury primarily in young middle-aged patients (mean age, 38.5 years; range, 26–53 years) [23], but with some variations (eg, average age, 47.9 years, range, 22–77 years [8]; and average age 49.3 years, range, 30–82 years [3]). Several investigations suggest that surgical repair for acute AT ruptures in mixed

and older populations provides satisfactory healing and rerupture rates [8, 27, 40, 58].

Relatively little information is available on specific results of management of acute AT tears in patients older than 65 years. Studies on older populations do not seem to have the same degree of success for AT repairs, with reduction of lower limb function (as evaluated with the heel-raise test), and high rate of complications (including rerupture, deep venous thrombosis, infections, sural nerve damage) following both surgical and nonsurgical management [46].

Concerns when dealing with elderly patients with AT rupture include the high incidence of comorbidities in this age group. Comorbidities can make it difficult for the patients to return to their previous state of activity and general immobility in the elderly may progressively impair the general health status. Aging also produces declines in neuromuscular function and reduced ability to recover balance from an imbalance episode, and from the biological features of the aging tendon. While it is tempting to presume an older patient will have worse tissue healing and, therefore, lower healing rates and higher infection and rerupture rates, the literature lacks data to support this presumption [45].

There is no consensus on the effect of age on the mechanical properties of tendons [28]. One study suggests that aging produces stiffer and stronger tendons [50], but other investigations led to the opposite conclusion [44, 54] or showed no effect of aging on most of the mechanical properties of the tendon [16]. In animals, tenocyte metabolism changes with increasing age [13], and these changes are accompanied by morphologic changes [6]. In humans, similar matrix alterations have been reported [31, 52]. This may result in uncertainty about the best treatment option to adopt in older patients with AT ruptures.

We therefore evaluated (1) the postoperative Achilles tendon total rupture scores (ATRS), (2) the maximum calf circumference, (3) the isometric plantar flexion strength, and (4) new episodes of rupture and complications in patients over 65 who underwent a percutaneous AT repair for acute AT ruptures.

Patients and Methods

We retrospectively reviewed 35 patients (26 men and nine women) over 65 years old at the time when they sustained an acute tear of the Achilles tendon. All had undergone percutaneous surgical repair of their AT tear between May 1996 and December 2003. We included patients if they (1) sustained an acute Achilles tendon rupture within 2 weeks of the index procedure; (2) had no previous injuries to the AT; (3) had a unilateral tear; (4) had not suffered from a

contralateral AT tear; (5) had not suffered a tear of another tendon in the ipsi- or contralateral limb; (6) were at least 65 years old at the time of the injury; and (7) had been operated within 48 hours of presentation. We excluded patients who had (1) an associated tear of another tendon in the ipsi- or contralateral limb; (2) previous surgery on the Achilles tendon; (3) a previous fracture of the ipsilateral calcaneus; (4) neuromuscular disorders; (5) an acute Achilles tendon rupture more than 2 weeks before the index procedure; and (6) suffered from inflammatory arthritis. The mean age at operation was 73.4 ± 8.7 years (range, 65–86 years). Thirty-one patients suffered their AT injury following indirect trauma, and four reported a direct hit on the affected Achilles tendon. The mechanism of injury was activity-related in 24 of 35 patients (seven golf, four hill walking, three fly fishing, five power walking, one playing badminton, two playing squash, one playing tennis, and one playing indoor soccer). The other 11 patients sustained the injury while pushing a car (three patients), lifting a heavy weight at home (one patient), stepping off the curb (one patient), descending a step (one patient), and falling off a bicycle (one patient). We invited each patient by mail, sending an introductory letter explaining the purpose of the study, and an information sheet explaining what the project entailed. If a package was returned with an “addressee unknown” notice, we performed an extensive search using the hospital database. Unfortunately, in no case were we able to locate these subjects. After 6 weeks from the original mailing, the package was resent to the nonresponders. If there was still no response, a followup telephone call attempted to encourage participation in the study. If this attempt failed, this was counted as a nonresponse. Of the 35 patients potentially able to participate in this study, we were able to locate 27 patients. Two of the eight remaining patients died of cardiovascular accidents, we were unable to locate three, and three declined to participate, declaring themselves fully healed and not seeing the point in attending. Based on the notes of the three patients who would not attend and enquiring with the relatives of the two patients who had died, we ascertained no reruptures had occurred in these eight patients, and that they had returned to a relatively normal life, including return to golf (one patient), power walking (two patients), and hill walking (one patient). The minimum followup of the reported 27 patients was 49 months (mean, 88 months; range, 49–110 months). Our institutional review board approved the study, and all patients gave written informed consent to participate in the study.

Our patients presented with the following comorbidities: five patients were hypertensive, six were on treatment for hyperlipidemia, seven had either hip or knee osteoarthritis for which they were taking oral analgesics or nonsteroidal antiinflammatory drugs, one had suffered from pulmonary

embolism, three had angina, two had a past medical history of deep vein thrombosis, and two had had a myocardial infarct more than 6 months from the AT rupture. In no instance did we change the drugs that these patients were taking for their underlying condition.

A single surgeon (NM) with a special interest in these injuries performed all the procedures. All patients were operated within 48 hours of presentation, and within 2 weeks of the original injury (mean, 5 ± 3.8 days; range, 1–14 days). Patients were operated on as day cases under local anesthesia and provided with 20 mL of 1% lignocaine (Boots Co., Nottingham, England) and 10 mL of Marcaine (bupivacaine injection; Abbott Laboratories Ltd, Maidenhead, England) or Chirocaine 0.5% (levobupivacaine injection; Abbott Laboratories Ltd, Maidenhead, England). All patients underwent percutaneous repair of the AT tear using the technique described by Sutherland and Maffulli [53] from 1996 to 2001, and the technique described by McClelland and Maffulli from 2002 to 2003 [38]. Briefly, in the technique by Sutherland and Maffulli [53], six stab incisions are performed, three over the lateral aspect and three over the medial aspect of the tendon. Four of these incisions are over the proximal stump and two just proximal to the insertion of the tendon on the calcaneus. The suture (a double-stranded 1 PDS II [Ethicon, Johnson and Johnson Intl, Brussels, Belgium] suture on a long curved needle) is passed through the stab incisions in a Bunnell fashion, crisscrossed through the tendon, and knotted outside the tendon itself with the ankle in plantar flexion. In the technique described by McClelland and Maffulli [38], three 3-cm transverse incisions are made over the Achilles tendon. The first is directly over the palpable defect. The other incisions are about 4 cm proximal and 4 cm distal to the first incision. A 1 PDS II double-stranded suture on a long curved needle is passed transversely through the distal incision passing through the substance of the tendon and out through the same incision.

The needle is then reintroduced medially into the distal incision through a different entry point in the tendon and passed longitudinally through the tendon, to lock the tendon, and is directed towards the middle incision and out through the ruptured tendon end. The suture still protruding from the distal incision is rethreaded onto the needle and reintroduced laterally into the distal incision and into the tendon. It is passed proximally through the tendon to exit from the middle incision. Traction is applied to the suture to ensure a satisfactory grip within the tendon. The same procedure is carried out for the proximal half of the ruptured tendon. A further 1 PDS II double-stranded suture can be placed in the tendon ends as described above in order to produce an eight-strand repair. The sutures are then tied in with the ankle in plantar flexion.

The patients' postoperative treatment and clinical followup was performed as previously described [34]. Following the percutaneous repair of the torn Achilles tendon, patients were immobilized with their ankle in a cast in gravity equinus, encouraged to bear weight on the operated limb as soon as possible to full weight bearing, and were discharged home on the day of the procedure. We did not routinely use postoperative venous thromboembolism prevention, except for the patients who were already on anticoagulant drugs for underlying comorbidities. All patients were given an appointment for review 2 weeks postoperatively, when they received a single cast change, with the ankle accommodated in a removable anterior splint in a plantigrade position, secured to the lower leg and foot with Velcro straps (Fig. 1).

Patients were reviewed during the sixth postoperative month. They were then followed up at 3-month intervals and discharged at 9 or 12 months after the operation, once they were able to perform at least five toe raises unaided on the operated leg and after they returned to their normal activities. Removal of the foot straps under supervision of a physiotherapist allowed the ankle to be plantarflexed fully

Fig. 1 Clinical photographs show three patients wearing the synthetic cast with Velcro straps with the ankle in equinus.

but not dorsiflexed, and to go into inversion and eversion [34, 35]. These exercises were performed against manual resistance provided by the physiotherapist for the first 2 weeks, and then the patients were encouraged to perform these exercises against elastic ropes and in isometric fashion against a wall. Six weeks postoperatively, the anterior splint was removed, and the patients were again referred to physiotherapy for active mobilization. The exercises described above were continued gradually increasing the load applied, with a view to starting eccentric exercises at 12 weeks from the procedure. Between weeks 6 and 12 from surgery, patients were encouraged to weight bear as much as possible, actively mobilizing the ankle in all directions against progressively increasing resistance. They were also asked to abstain from hopping, jumping, jogging, and running until 12 to 16 weeks from the operation. No heel raise was used, and patients and their physiotherapist were asked not to perform active or passive stretching of the ankle, but to concentrate on active motion.

We performed preoperative evaluations the day of surgery. Each patient was evaluated for limb dominance, trauma history, duration and type of preoperative symptoms, and postoperative Achilles tendon total rupture score (ATRS) [48]. Clinical examination consisted of evaluation of ankle motion, skin sensitivity, the homogeneity of the tendon, and adherence between skin and tendon. We performed no imaging assessments. The Achilles tendon total rupture score (ATRS) [48] was used to evaluate postoperative patient symptoms and physical activity outcome after treatment of Achilles tendon rupture. The maximum calf circumference was measured in both the affected and the contralateral leg by using a commercially available steel tape measure [15, 19]. All measurements were taken at a special clinic by a measurer (AK) trained in anthropometric techniques who was able to reproduce within 5% the duplicate measurements on the same calf [25, 30]. The duplicate measurements correlated with one another ($r = 0.91$, $p = 0.0023$).

We determined isometric plantar flexion strength of the gastrosoleus muscle complex bilaterally with the ankle at neutral (0°) position by using a custom-made apparatus [29]. The apparatus consists of a footplate, the angle of which could be varied and locked into a given position. An analog-to-digital converter (ADC-10, PICO Technology, Cambridge, UK) connected the strain gauge on the footplate to a voltmeter (Picoscope, PICO Technology). In its turn, the voltmeter was connected to a computer. The changes in voltage were then converted into Newtons to measure strength. The apparatus was calibrated by suspending known weights from 2.5 to 37.5 kg before and after each patient was tested, giving a linear response. Each patient supported the lower limb in the leg rest, with the

heel placed firmly at the top of the footplate and with the plantar aspect of the foot resting at ease. The patient was then asked to exert maximal isometric force on the footplate for 3 to 5 seconds. The maximum result was noted. The amplifier was used each time to return the voltmeter to 0. Each patient performed two maximal attempts, and the average was used for further analysis. For technical reasons, we were not able to measure isometric strength in five of the 27 patients who attended for the purposes of the present study.

Complications were divided into three categories: minor, general, and major. Minor complications included wound complications. General complications were indicated as pain, swelling, and weakness of the calf muscle complex. Major complications included deep infections; chronic infection; deep vein thrombosis; pulmonary embolism; tendon lengthening; and death.

Three orthopaedic or sport and exercise medicine trainees (UGL, AK, MR) who had not been involved in the initial treatment of the patients involved in the present study assessed all the patients. The trainees had received specific training for the purposes of this study. The study involved procedures and clinical assessments not normally undertaken in everyday clinical practice. These included anthropometry measurements, the administration of questionnaires, and the measurement of isometric strength, for which the three authors received specific training.

Descriptive statistics were calculated. We determined differences in the maximum calf circumference between the operated and the nonoperated leg, and the isometric plantar flexion strength between the operated and the nonoperated leg using the Wilcoxon sign rank test. We used SPSS for Windows, version 8.0 (SPSS, Inc., Chicago, IL) for all analyses.

Results

All patients were able to bear weight fully on the affected limb by the eighth postoperative week. The mean ATRS rating of the 27 patients was 69.4 (range, 56–93). The maximum calf circumference was decreased ($p = 0.02$) in the operated limb (48 ± 8 cm versus 42 ± 9.3 cm). The operated limb was always weaker ($p = 0.033$) than the nonoperated one. Isometric plantar flexion strength of the gastrosoleus muscle complex was decreased ($p = 0.04$) in the operated limb ($N 312 \pm 120$ versus 372 ± 128).

Two patients (7%) experienced a new episode of rupture after the index surgery. These two patients were only partially compliant with the rehabilitation protocol, and protected the operated limb in the cast for only 2 and 4 weeks after surgery, respectively. They presented with a limp and clinical evidence of a rerupture at 6 and 9 weeks

following the index procedure, having defaulted their 6-week appointment. They underwent reconstruction of the Achilles tendon using a transfer of the tendon of peroneus brevis [4, 37]. Three patients (11%) experienced a superficial infection: these were managed with oral antibiotics. In one of these patients, the knot of one of the sutures became prominent through the skin, and was removed surgically 9 weeks after the index procedure. The surgical wound was reopened, thoroughly irrigated with normal saline and oxygen peroxide, and left open to granulate. It healed by second intention over a period of 3 weeks, with no adverse effects to the tendon. Three patients (11%) had hypesthesia over the area of distribution of the sural nerve. The hypesthesia resolved over 6 months in two of the three patients. In the third patient, the hypesthesia persisted but did not interfere with the patient's activities of daily living or with the wearing of shoes. Two patients (7%) developed a deep vein thrombosis, and were managed with oral anticoagulants for 3 months with no adverse effects. There were no vascular complications from an iatrogenic injury to a vessel. Five patients (18.5%) had evidence of adhesions between the tendon and the skin, but none reported it as a problem.

Of the 24 patients in whom the injury was activity-related, none returned to playing badminton, squash, tennis, or indoor soccer. Of the others, four returned to golf, two to hill walking, three to fly fishing, and three to power walking.

Discussion

Percutaneous repair for acute rupture of the AT reportedly reduces the risk of rerupture compared to nonoperative treatment, and produces lower risk of other complications, including wound infection [11, 18]. We expected complications of AT surgery to occur more commonly in older patients when compared to younger populations because of the greater number of comorbidities in this age group. Therefore, we determined the postoperative ATRS, the maximum calf circumference, the isometric plantar flexion strength, and the new episodes of rupture and complications in a series of 35 patients over age 65 who underwent a percutaneous repair for an acute AT rupture, and compared our results with those of previous reports on younger populations.

Our study has a number of limitations. First is the absence of nonoperated control patients. We can only infer comparisons based on the literature. Second, we did not include a younger-age control group. Although percutaneous repair is well-established for the treatment of AT tears, comparisons are limited to one study reporting the treatment of AT tears in patients over 65 years old [46].

Third, in comparing outcomes of surgical repair of an acute AT rupture we used the ATRS as our main outcome measure. Since this was described in 2007 [48], it has not been widely used. However, the ATRS is the only validated patient-reported instrument for measuring outcome after treatment for total AT rupture although we are aware of only two other studies in the literature using ATRS [42, 48]. In the first, Nilsson-Helander et al. [48] developed and validated the ATRS. The total ATRS ranged from 17 to 100, with a mean (median) of 77 (85) and a SD (interquartile range) of 21.4 [48]. However, as the study aimed to present the new score designed by the authors and not to report on specific results of the management of AT ruptures, data are not reported in a way that allowed us to perform a strict comparison with the results of our own investigation. The second study [47] focused on patients with a chronic rupture or rerupture of the Achilles tendon, and therefore the results of that study are not comparable with ours. Therefore, a strict comparison with the results of our study is not possible. Finally, we used unvalidated methods of assessment.

We found the maximum calf circumference decreased in the operated limb. Our findings support the findings in previous studies in terms of permanent calf muscle atrophy in younger patients [15, 22, 41, 59]. We were not able to retrieve any study specifically reporting on maximum calf circumference in older patients after an acute AT rupture.

The isometric plantar flexion strength of the gastrosoleus muscle complex was decreased in the operated limb. This finding is in accordance with most previous studies showing a permanent deficit in isometric plantar flexion strength after AT ruptures [7, 14, 17, 18, 41, 43, 51, 55] in mixed populations. In our patients, the decrease in isometric strength of the gastrosoleus complex compared to the unaffected limb remains more pronounced than that reported in the general population with acute AT ruptures [56], despite the active rehabilitation program. It is possible that, although aging muscles can be trained [45], the effects of an acute AT rupture are difficult to overcome despite prompt minimally invasive surgery and appropriate rehabilitation [32, 58]. In this study, we measured the isometric strength of the gastrosoleus muscle complex of the affected and normal sides [34]. Strength measurements can be influenced by discomfort experienced in the Achilles tendon when contracting the gastrosoleus complex [56]. Under these conditions, muscle contractions may not be maximal in a physiological sense, but they do represent the maximum ability of the patients to produce force in a given situation. To confirm whether patients were producing a maximal effort, electromyography could have been used. However, this technique was not available to us, and we have no reason to doubt the willingness of our patients enrolled in this study to exert themselves maximally.

Nestorson et al. [46] retrospectively analyzed the clinical outcome of 25 patients older than 65 years with acute Achilles tendon rupture. In that study, the initial treatment was nonsurgical in 10 patients, surgical in 14 patients, and one patient received no treatment. Fourteen complications occurred in 11 patients. Five of 25 patients (20%) sustained a rerupture (four following initial closed treatment with plaster). In our study, we had two of 27 patients (7%) with a new episode of rupture. Our results were comparable in terms of complications to the study of Nestorson et al. [46]. One patient of that study had a deep venous thrombosis, and four had superficial infections requiring antibiotics. One patient sustained a fibular nerve injury following compression by the plaster cast, and another a sural nerve injury during surgery. Two patients had symptoms from adhesions between the tendon and the skin. The authors concluded that AT rupture in patients older than 65 years reduces lower limb function, and that complications are common following surgical management. No ATRS data were presented in that study [46].

Percutaneous repair is becoming a well-accepted modality in the management of acute AT tears [10, 39] and yields similar rerupture rates when compared to open techniques [12, 21]. The major advantages of percutaneous repair are less iatrogenic damage to normal tissues, less postoperative pain, accurate opposition of the tendon ends minimizing surgical incisions, thus protecting against wound breakdown and wound complications [49], and improved cosmesis. Although sural nerve injury has been reported as a potential complication of this kind of surgery [57], new techniques have minimized the risk of sural nerve damage [5]. Indeed, our own work in this respect confirms that sural nerve problems can be minimized using local anesthesia and newer percutaneous repair techniques [5]. Lim et al. [23] randomized 66 young patients (mean age, 38.5 years; range, 26–53 years) to compare open and percutaneous repair of closed AT ruptures. They had a higher rate of complication in open repair. There were 7/33 (21%) wound infections and two reruptures (6%) in the open group compared to 3/33 cases of wound puckering (9%), one rerupture (3%), and one case of persistent paresthesia in the sural nerve territory (3%) in the percutaneous group. They advocated percutaneous repair on the basis of the low rate of complications and improved cosmetic appearance. Given these findings, we also advocate percutaneous repair in older patients with AT rupture to minimize the rate of infections arising from traditional open repairs [46]. The incidence of complications in this population of young patients is similar to that obtained in our older patient study group. In our hands, the rate of sural nerve injuries was low, and this we believe reflects the fact that the procedure is performed under local anesthesia, and the accurate placement of the surgical incisions. The lower

rate of iatrogenic sural nerve injuries reported using these techniques is comforting and reflects the experience of other authors [9]. Despite using a percutaneous technique in older patients in whom we anticipated reduced healing potential [45], the rate of Achilles tendon rerupture was low and comparable with that reported using open techniques [10]. This is not a new finding, though, and we presume it reflects the use of stronger suture materials and a percutaneous suture configuration comparable to that described in open procedures [11, 23]. We speculate it may also be a consequence of the early active rehabilitation which we advocate following these injuries [34].

The rate of return to a relatively high level of physical activity was markedly lower than that reported in other studies on treatment of Achilles tendon ruptures [41, 42]. This likely reflects the fact that our study population was older than the typical patients with such injury [41, 42]. In this age group, inevitably activity levels fall [2], although it could be argued that our sample is biased, as the patients who may have opted for percutaneous repair may have been more active to start with.

Our data suggest that percutaneous repair under local anesthesia for acute AT ruptures in patients older than 65 years gives good results in terms of postoperative ATRS, maximum calf circumference, and isometric plantar flexion strength.

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