# A Systematic Review of Tibialis Anterior Tendon Rupture Treatments and Outcomes

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## Abstract

Tibialis anterior (TA) tendon rupture is a relatively rare injury that has been documented primarily in case reports.

This article is the first large systematic review of the literature on treatment techniques for subcutaneous rupture of TA tendons. Studies for review were identified through a PubMed search. Eligible studies involved cases of closed tendon rupture.

Of the 87 cases in the study, 72 were treated with surgery, 15 with conservative measures. Mean age was 63.9 years (surgery group) and 72.4 years (conservative treatment group). Primary repair was used most often for newer injuries, autograft most often for older injuries.

Operative repair of subcutaneous TA tendon rupture leads to successful outcomes in many patients. A surgeon who is deciding which operative technique to use for a patient should consider the age of the injury and the findings of intraoperative assessment for tendon necrosis.


Subcutaneous rupture of the tibialis anterior (TA) tendon has been reported predominantly in case reports and small case series because of the relative rarity of the injury. Unlike traumatic lacerations or open injuries to the tendon, subcutaneous injuries often go unnoticed by patients because of compensation by surrounding dorsiflexors of the foot and toes—namely, the extensor hallucis longus (EHL) and the extensor digitorum longus (EDL).[1] This can delay presentation to an orthopedic surgeon and lead to difficulties in treatment, such as allograft or autograft being required if primary repair is no longer possible. Case reports and series have described treatment methods as well as anecdotal evidence of outcomes after operative repair or conservative treatment, but there have been no comprehensive systematic reviews of outcomes after various types of treatment. Authors have come to conclusions about expected outcomes based on patient age, time to treatment, treatment used, and other variables, but no reviews have examined these variables across multiple studies. Given the low level of the evidence presented in most of these reports, it is difficult to perform a meta-analysis of the data.

Instead, we systematically reviewed 87 cases from all pertinent studies and examined commonly reported data, such as patient age, time to treatment, treatment used, and outcome. Using the PICO (population, intervention, comparison, outcome) model for systematic reviews, we looked at patients who had closed, spontaneous, complete rupture of the TA tendon and underwent operative repair or conservative treatment of the injury. Outcomes surveyed included successful operative repair or conservative treatment, as measured by objective systems, such as MMSS (Manual Muscle Strength Scale) score, AOFAS (American Orthopaedic Foot and Ankle Society) hindfoot score, and FAOS (Foot and Ankle Outcome Score) testing, or by subjective description of posttreatment outcome.

We intend this review to serve as a guide for surgeons who find themselves treating a ruptured TA tendon, a relatively rare injury. They will be able to select the operative technique or conservative treatment that best matches the patient's needs, based on comparison with previous case studies.

## Materials and Methods

The cases reviewed for this study were found through a comprehensive PubMed search and an independent review of references cited in similar articles. Articles included were published between 1975 and 2012, inclusive. The latest search was performed on March 22, 2013. The search criteria were tibialis anterior [Title/Abstract] OR anterior tibial [Title/Abstract] AND rupture [Title/Abstract]) AND surgery. Only English-language articles, or articles already translated into English, were included. Eligible studies described cases of closed tendon rupture. No traumatic lacerations or open ruptures were included. If a study described both open and subcutaneous ruptures, only the subcutaneous cases were included. Further, partial ruptures were not included. In addition, ruptures caused directly by a known comorbid condition—for example, a rupture caused by a gouty tophaceous deposit at the site of rupture[2]—were not included. Data were extracted from publications independently and analyzed in a Microsoft Excel workbook (Microsoft, Redmond, Washington). Variables examined included patient age and sex, side involved, time to treatment, mechanism of injury, defect size, predisposing comorbidities, surgery or conservative treatment, type of operative repair (if applicable), graft used (if applicable), pretreatment function (by independent scoring system, if applicable), and posttreat-

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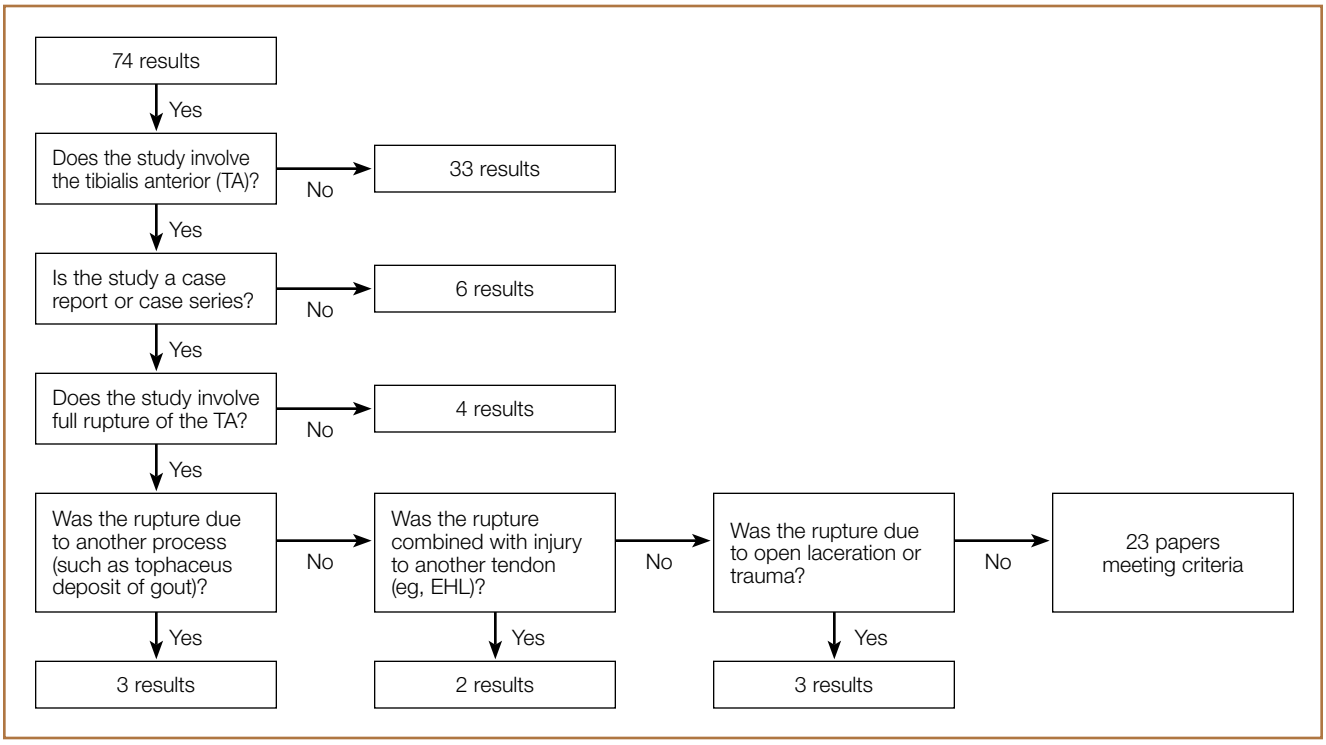


Figure 1. Algorithm for PubMed search.

ment function. These variables were not necessarily reported in all the studies.

A potential bias exists in our PubMed search. As the query was specific for studies that included operative repair of a ruptured TA tendon, case studies that involved only conservative treatment were excluded. However, the primary goal of this review was to compare operative possibilities and the patient characteristics and outcomes associated with these surgeries.

## Results

**Figure 1** shows the criteria used to select eligible papers for review. Twenty-three papers matched the criteria.[3-25] Data were independently extracted from these papers, as described in the Methods section. Again, not all variables were reported by all authors. Sammarco and colleagues[21] reported time to treatment as a mean for 2 groups: 8 cases defined as "early" treatment (mean time to treatment, 0.625 months) and 11 defined as "late" treatment (mean time to treatment, 10.7 months). These mean times were therefore used independently for each case in calculating mean time to treatment for this systematic review.

**Table 1** lists the demographics. There were 40 male and 25 female patients, and 22 cases in which sex was not specified. Mean age was 63.9 years (surgery group), 72.4 years (conservative treatment group), and 65.8 years (overall). Of the 87 patients, 72 underwent surgery, and 15 were treated with conservative measures.

**Table 2** lists the operative techniques identified. Of the 72 surgeries, 23 were primary repairs, 12 were primary repairs of the anatomical insertion, and 18 involved use of autograft.

Time to treatment was available for 54 of the 87 cases (**Table 3**). Primary repair was most often performed in cases in which the injury was less than 3 months old, and autograft was most often used in cases in which the injury occurred more than 3 months before presentation.

Posttreatment outcome scores were available for 59 cases. Only 3 authors reported preoperative scores.[5,21,24] None of the authors who used conservative treatment measures reported

Table 1. **Demographics**

| **Sex** | **n** |
|---|---|
| Male | 40 |
| Female | 25 |
| N/A | 22 |
| Total | 87 |
| **Mean Age** | **y** |
| Surgery | 63.9 |
| Conservative | 72.4 |
| All | 65.8 |
| **Treatment Type** | **n** |
| Surgery | 72 |
| Conservative | 15 |
| Total | 87 |

**Table 2. Operative Techniques**

| Surgery Type | n |
|---|---|
| Primary repair (with Achilles tendon lengthening) | 23 (4) |
| Primary repair to anatomical insertion | 12 |
| Allograft | 1 |
| Sliding tendon lengthening (with repair to navicular) | 6 (1) |
| Extensor hallucis longus transfer (with Achilles tendon lengthening) | 9 (5) |
| Extensor digitorum longus transfer with Achilles lengthening | 1 |
| Autograft | 18 |
| Extensor digitorum longus | (7) |
| Achilles | (2) |
| Hamstring | (3) |
| Plantaris | (5) |
| Tibialis anterior, proximal stump | (1) |
| Repair to nonanatomical insertion | 2 |
| Talus | (1) |
| Navicular | (1) |
| **Total** | **72** |

**Table 3. Time to Treatment Affects Treatment Used**

| | Time to Treatment, n | |
|---|---|---|
| **Treatment Type** | ≤3 mo | >3 mo |
| Operative | | |
| Primary repair | 11 | 5 |
| Primary repair to anatomical insertion | 6 | 0 |
| Autograft | 6 | 8 |
| Sliding tendon lengthening | 1 | 1 |
| Allograft | 0 | 1 |
| Extensor hallucis longus transfer | 1 | 0 |
| Repair to navicular | 0 | 1 |
| Conservative | 7 | 6 |
| **Total** | **32** | **22** |

**Table 4. Scores After Surgery and Conservative Treatment**

| | | Mean Posttreatment Score | |
|---|---|---|---|
| **Scoring System** | **Cases, n** | Surgery | Conservative |
| AOFAS hindfoot score (out of 100) | 16 | 88.9 | — |
| FAOS (out of 100) | 17[a] | 84.4 | 69.4 |
| MMSS score (out of 5) | 26 | 4.7 | — |
| Tinetti gait and balance score (out of 28) | 3 | 24.7 | — |

Abbreviations: AOFAS, American Orthopaedic Foot and Ankle Society; FAOS, Foot and Ankle Outcome Score; MMSS, Manual Muscle Strength Scale.

[a]8 surgery, 9 conservative.

pretreatment scores. Scores used included the MMSS score (26 cases), the AOFAS hindfoot score (16 cases),[26] the FAOS (17 cases),[27] and the Tinetti gait and balance score (3 cases; the author also used the MMSS score).[28] **Table 4** lists the mean posttreatment scores for patients who underwent surgery and patients treated conservatively. AOFAS, MMSS, and Tinetti scores and FAOS were used by authors presenting operative treatment outcomes. Only posttreatment FAOS was available for both surgery (84.4/100) and conservative treatment (69.4/100).

## Discussion

Closed rupture of the TA tendon is a relatively rare entity occurring mostly in older patients without any history of acute, traumatic injury. Some patients, however, recall a particular moment of rupture, often accompanied immediately by pain and swelling, which eventually resolve. Later sequelae include footdrop with associated steppage gait and a palpable mass on the dorsal aspect of the ankle.[3,21] Chronic TA tendon rupture can also lead to clawing of the toes as the other foot extensors (EHL, EDL) overcompensate. Cohen and Gordon[1] described the case of a patient who ruptured a TA tendon 25 years earlier and then, in the absence of operative repair, developed hypertrophy of the EHL and the EDL. This extensor substitution led to hammer toes and plantar prominence of the metatarsal heads, ultimately leading to moderate pain and a neuroma. Although this particular outcome is likely rare, the more common sequelae of footdrop, flatfoot, Achilles tendon contracture, and compromised gait are reason enough to consider operative repair for any ruptured TA tendon.

Most previous studies of TA tendon rupture were case reports and case studies. In the largest series, Sammarco and colleagues[21] described 19 cases of closed rupture. These included 3 traumatic cases, 1 by blunt trauma to the tendon and 2 of open laceration, all treated surgically with various methods. Unfortunately, these 3 traumatic cases were not separated in the authors' analysis and therefore had to be included in this systematic review. Including them here did not compromise our goals in this review, which included examining typical patient demographics and the most common methods of operative repair.

Conservative measures remain a treatment possibility for some patients. We found that patients treated with conservative measures historically have been older (mean age, 72.4 years) than patients treated surgically (mean age, 63.9 years). However, advanced age itself is not a contraindication for operative repair of a TA tendon rupture, and authors have described positive outcomes for active, elderly (>70 years) patients who wanted to maintain their activity level and therefore opted for operative repair.[7,8,10,13,16,24] Ouzounian and Anderson[18] described functional limitations (eg, persistent footdrop, slapfoot gait, limitations in walking) after conservative treatment with an ankle-foot orthosis. Operative repair offers the chance for better functional outcome for patients who are surgical candidates and lead even a mildly active lifestyle.

Of operative repair methods, primary repair is used most

often. This technique, however, must be allowed by the gap between the 2 ruptured ends after débridement of any necrotic tissue. If the distal stump is not viable, primary repair of the proximal stump to the native anatomical insertion is feasible. **Figure 2**, reprinted from a case report by Rajagopalan and colleagues,[19] shows a ligament–osseous reattachment of the proximal stump using suture anchors to the medial cuneiform. Both primary repair and repair to the anatomical insertion can be augmented with Achilles tendon lengthening if needed to achieve balance between flexor and extensor functions of the ankle.

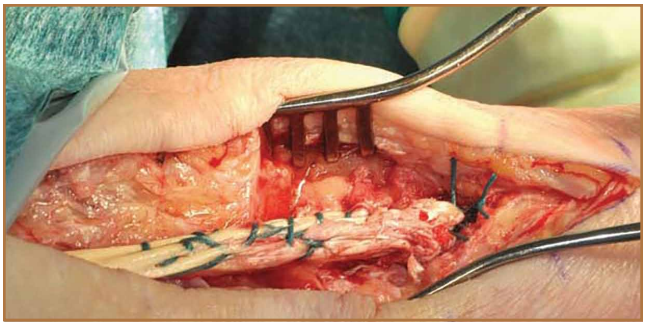

Figure 2. Repair with suture anchors to cuneiform. Rajagopalan S, Sangar A, Upadhyay V, Lloyd J, Taylor H. Bilateral atraumatic sequential rupture of tibialis anterior tendons. *Foot Ankle Spec*. 2010;3(6):352-355, copyright © 2010 by SAGE Publications. Reprinted by permission of SAGE Publications.

If the gap between the 2 stumps cannot be covered by the native tendon, then autograft, another surgical technique with positive outcomes, can be used. The most popular autograft sites historically have been the EDL, Achilles, and plantaris tendons. In addition, Goehring and Liakos[9] described 3 cases of good results with semitendinosus autograft. Sapkas and colleagues[22] used a free-sliding TA graft harvested from the healthy tissue of the proximal tendon stump. Their technique is depicted in **Figure 3**. Sliding tendon lengthening, well described by Trout and colleagues[24] in a case study, is feasible for use of the native tendon when there is a gap to bridge between the 2 stumps of ruptured tendon. EHL or EDL transfer with or without Achilles lengthening is another option, albeit historically less often used.[6,7] This technique is depicted in **Figure 4**, reprinted from a case series by Ellington and colleagues,[7] who used EHL transfer with and without Achilles tendon lengthening in 9 cases.

Last, less popular techniques have included repair to sites other than the medial cuneiform, including the neck of the talus and the navicular bone.[10,13] An Achilles tendon allograft was used in a case described by Aderinto and Gross[3] to repair a ruptured tendon found incidentally on preoperative exami-

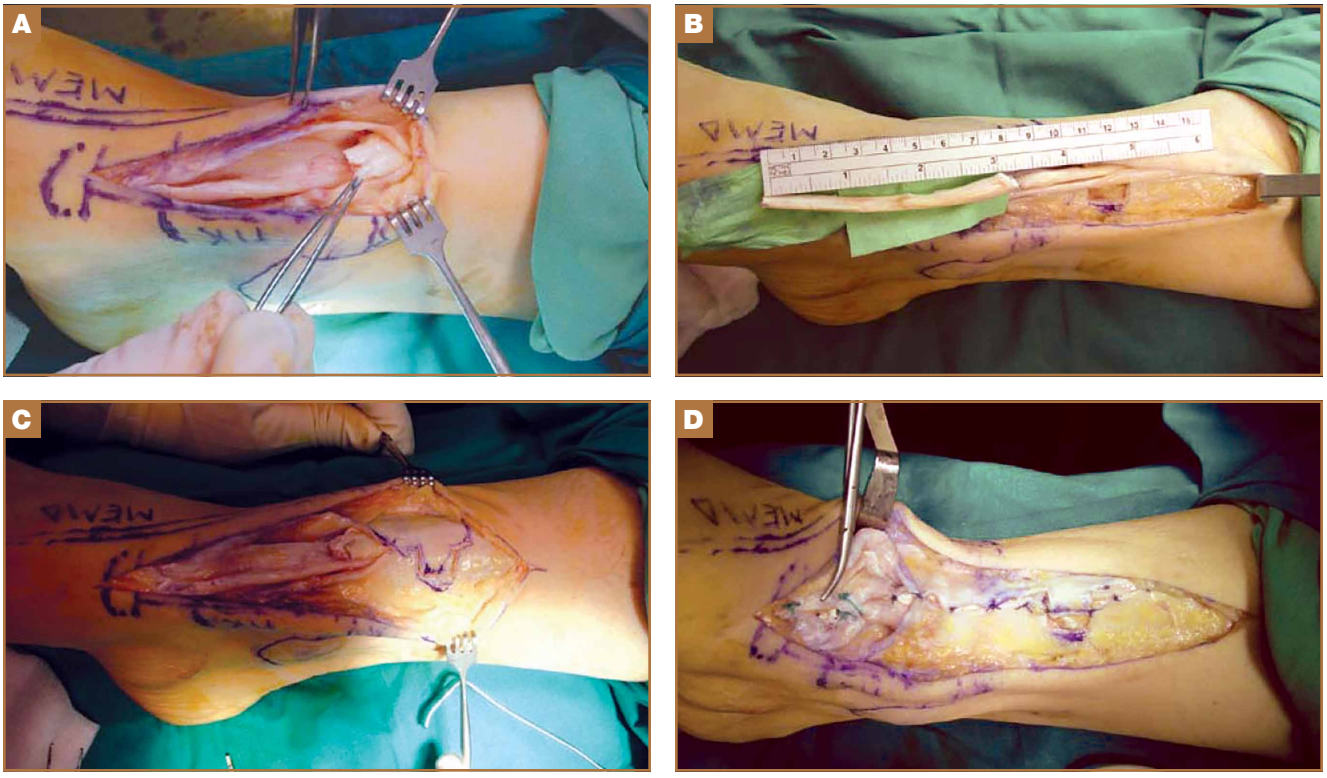


Figure 3. (A) Proximal stump of tendon after longitudinal incision of its thick inflammatory sheath. (B) Free-sliding tibialis anterior tendon graft harvested after longitudinal incision of its thick inflammatory sheath. (C) Step-cut release of superior retinaculum. (D) Graft inserted into base of first cuneiform and fixed with bone anchor. Reprinted from: Sapkas GS, Tzoutzopoulos A, Tsoukas FC, Triantafillopoulos IK. Spontaneous tibialis anterior tendon rupture: delayed repair with free-sliding tibialis anterior tendon graft. *Am J Orthop*. 2008;37(12):E213-E216.

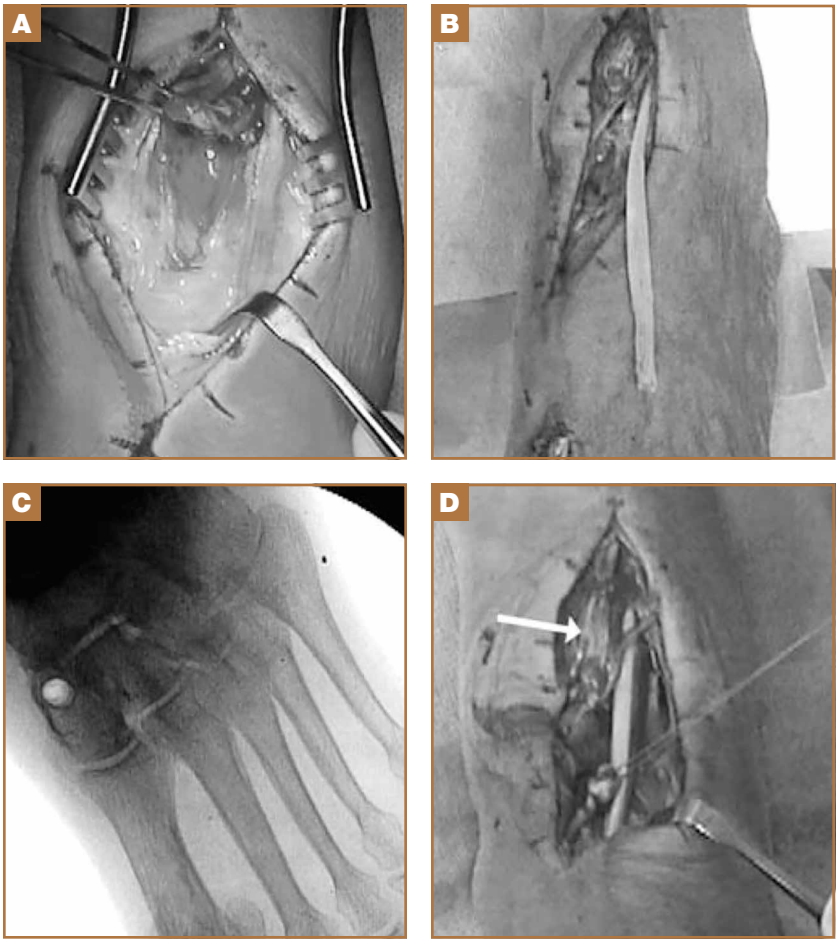


Figure 4. Extensor hallucis longus (EHL) tendon transfer. (A) Forceps holding proximal stump of tibialis anterior rupture. (B) EHL tendon harvested with distal counterincision. Extensor hallucis brevis tendon and EHL are tenodesed through distal incision (not shown). (C) Intraoperative fluoroscopy shows cuneiform tunnel through which EHL tendon will be passed. (D) EHL tendon has been passed through bone tunnel and is sutured back to itself in maximal tension. Proximal tibialis anterior stump is sewn side-to-side to EHL tendon (not shown). Ellington JK, McCormick J, Marion C, Cohen BE, Anderson RB, Davis WH, Jones CP. Surgical outcome following tibialis anterior tendon repair. *Foot Ankle Int*. 2010;31(5):412-417, copyright © 2010 by SAGE Publications. Reprinted by permission of SAGE Publications.

nation for a scheduled knee arthroplasty. The patient had a postoperative MMSS score of 4/5.

Overall, primary repair is clearly preferred, but successful outcomes can be achieved by other means. As **Table 3** shows, primary repair is more often used for ruptures less than 3 months old, and autograft for older ruptures. Although which operative technique to use can be decided after necrotic tissue is débrided, surgeons should try to ascertain age of injury ahead of time so that, going into surgery, they will have a better idea of the feasibility of primary repair.

Posttreatment ankle scores were not widely available. As **Table 4** indicates, only FAOS was used for the conservative treatment cases. However, raw mean FAOS and raw mean AOFAS hindfoot, MMSS, and Tinetti scores showed that good outcomes and high scores can be achieved with surgery. Further, the mean FAOS reported by Gwynne-Jones and colleagues[10] and Markarian and colleagues[13] showed a clinically significant difference between surgery and conservative treatment. DiDomenico and colleagues,[5] Sammarco and colleagues,[21] and Trout and colleagues[24] were the only authors who reported pretreatment and posttreatment scores.

We intend this systematic review of the literature on closed TA rupture to serve as a guide for surgeons who find themselves treating this relatively rare injury, which often presents with only a chief complaint of the foot catching while walking. Overall, the literature shows that operative repair provides very good outcomes for many patients. Patients who are surgical candidates and amenable to surgery can be counseled that operative repair leads to fewer sequelae, such as persistent footdrop and flatfooted gait, with a strong likelihood of return to baseline activity status. Patients who are not surgical candidates or are strongly against surgery can be offered conservative treatment with an ankle-foot orthosis or physical therapy, but they should also be counseled that persistent gait abnormalities and weakness in dorsiflexion are likely outcomes. Surgeons must also consider age of injury (time from probable rupture to presentation), estimating a particular moment of rupture if unknown by the patient. They can then gauge the feasibility of primary repair and, during surgery, decide which technique (primary repair, tendon transfer, autograft, or other technique) will produce the best results. They can also use scores such as the FAOS and the AOFAS hindfoot, MMSS, and Tinetti scores to compare preoperative and postoperative function, though subjective reports of return to previous activity can also serve as markers of successful repair.

This review highlights the need for further study regarding the treatment of TA ruptures. Larger, randomized studies with validated scoring systems for preoperative and postoperative function would offer more insight onto the best treatment options for these complex injuries.

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