Repair of Chronic Tibialis Anterior Tendon Ruptures

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Abstract: This article presents a novel technique for repair of chronic tibialis anterior tendon ruptures. All chronic tibialis anterior tendon ruptures reviewed were treated with this technique. Patients with chronic tibialis anterior tendon ruptures presenting to the authors’ institution from 2006 to 2012 had preoperative and postoperative Foot and Ankle Ability Measure scores. The average follow-up time was 2.1 years. The average Foot and Ankle Ability Measure score was 66.1% preoperatively and 87.1% postoperatively (P=.002). This technique offers theoretical improved strength and may help avoid the need for tendon graft often required by other techniques. [Orthopedics. 2016; 39(2):e386-e390.]

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The tibialis anterior supplies 80% of the dorsiflexion power of the ankle. Deficiency results in a significant functional deficit.1,2 Tibialis anterior tendon ruptures occur traumatically and atraumatically. Atraumatic ruptures occur after the age of 45 years following eccentric loading of a degenerated tibialis anterior tendon against a plantarflexed ankle and often present delayed. Patients with inflammatory arthropathy, gout, and diabetes mellitus and patients receiving corticosteroid treatment are at risk for degeneration and atraumatic rupture of the tendon.1,3-8 Previous studies have identified a hypovascular zone as 45 to 65 mm in total length starting approximately 5 mm proximal to the insertion site.9-11 A significant number of ruptures are at the most distal 5 to 30 mm of the tendon, correlating with the hypovascular zone.10-12 Patients present with a triad of findings, including a pseudotumor at the anteromedial aspect of the ankle, loss of the contour of the tibialis anterior tendon over the ankle, and the use of the extensor hallucis longus and extensor digitorum longus to dorsiflex the ankle.1,7 Gait is typically foot slap or steppage with a propensity for toe dragging.1 Case studies have described these injuries and potential treatments, but there is no consensus regarding treatment.4,8,12-14

Direct repair of the tendon is ideal when possible with adequate healthy tendon stalk proximally and distally. Acute tendon laceration is often amenable to direct repair. However, atraumatic ruptures often occur at the distal end of the tendon at the site of bony insertion, and often present late due to the difficulty of diagnosis.7 Current repair techniques involve suture anchor and bone tunnel repair with the use of a tendon graft.4,8,12-14 These techniques frequently implement a graft, with associated morbidity of harvesting, and can result in a bulky repair. Repair with pull-out suture over a button on the plantar surface requires bone to tendon healing to afford repair strength once the button is removed, and the button can cause skin complications.13 Distal biceps ruptures are more common and have been thoroughly studied in relation to the biomechanics of differ-
figure 1a). In most cases, figure 1b-c). which was guided
figure 2a-b). Statistical analysis was per
patient age and activity level. the questionnaire due to average
analyzed, excluding the sport
activity of daily living ques
results previously recorded
compared with preoperative
was the Foot and Ankle Ability
was the Foot and Ankle Ability
was minimally debrided
tendon stump and pseudoten
tendon stump was identified and was insufficient for direct repair.

The tendon insertion site
The tendon insertion site
drill pin was used to create a bicortical tun
tunnel and was left in place (figure 1b). A 7-mm reamer was placed over the guide pin and a unicortical tunnel was reamed, ensuring adequate depth of the tunnel and that the far cortex was not reamed. The drill pin and reamer were removed and the bone tunnel was irrigated to remove any debris.

To confirm the tendon
lous bone compared with the
proximal radius, the authors have found that overdri
ing leads to an inadequately con
strained tunnel.

The FiberLoop suture,
which had been previously cut
to remove the suture needle,
was then threaded on to the
BicepsButton (Arthrex), with each limb entering the oppo
site hole and exiting through the entry hole of the opposite suture.

The EndoButton was then
placed on the inserter (figure 1d), which was guided through the medial cuneiform bicortically. After passing through the far cortex, the En
doButton was deployed and flipped into position and the tendon was pulled into the bony tunnel (figures 2a-b). The authors’ goal was to place
15 to 20 mm of tendon into the tunnel with good tendon ten
sion with the ankle at maxi
materials and methods

After obtaining institutional
review board approval, the
electronic medical records of
all patients who had a tibialis
anterior tendon rupture from
2006 to 2012 were evaluated.
For each patient, demographic
data and outcome data were
de-identified and recorded in a
REDCap database.18 The clinical
outcome used for this study
was the Foot and Ankle Ability
Measure (FAAM) score, which
is a validated outcome measure
for foot and ankle injury and
disease.19 Seven patients were
identified presenting 4 to 25
weeks after the injury.

Patients were contacted and
consented for inclusion in the
study. A posttreatment FAAM
tool was administered. This
postoperative outcome was
compared with preoperative
results previously recorded in
the medical record. The activity of daily living ques
naire of the FAAM was
analyzed, excluding the sport
questionnaire due to average
patient age and activity level.
Statistical analysis was per
formed with univariate analy
sis with the Mann-Whitney U
test. Stata statistical software,
release 11 (StataCorp, College
Station, Texas), was used.

Preoperatively, each pa
tient was assessed for equinus
contracture, which can be ad
dressed with Strayer or Achil
les lengthening.

operative technique

An anteromedial incision
was made overlying the tibialis
anterior tendon from the me
dial cuneiform to the level of
the superior retinaculum. The
proximal end of the ruptured
tendon was retracted, and in
the cases of chronic rupture,
significant pseudotendon had
usually formed. The distal
stump was identified and was
insufficient for direct repair.

The tendon insertion site
was debrided of the distal ten
don remnant. The proximal
tendon stump and pseudoten
don was minimally debrided
to healthy tissue that would
hold suture, and length was
assessed with traction. The
medial cuneiform was the in
sertion site.

Fluoroscopy was used to
confirm the starting point of
the bone tunnel and the trajec
tory to ensure adequate bone
stock surrounding the graft/
bone tunnel (figure 1a). Then,
a 3.2-mm drill pin was used
to create a bicortical tun
nel and was left in place (fig
ure 1b). A 7-mm reamer was
placed over the guide pin and a
unicortical tunnel was reamed,
ensuring adequate depth of the
tunnel and that the far cortex
was not reamed. The drill pin
and reamer were removed and
the bone tunnel was irrigated
to remove any debris.

To confirm the tendon
would pass through a 7-mm
bone tunnel, the proximal
tendon stump was sized with
a 7-mm sizing block. The ter
minal 2.5 cm of the proximal
stump of the tibialis anterior
tendon was then whip stitched
using No. 2 FiberLoop (Ar
threx) with a straight needle
in a locking fashion. The final
throw was locked proximally
prior to exiting the tendon end
(figure 1c). In most cases,
pseudotendon was incor
rated into the repair to extend
the working length of the ten
don. The suture was begun
in healthy tendon, and only
pseudotendon that would hold
suture was used.

Using a 7-mm reamer is a
deviation from the technique
for the distal biceps repair kit.
The standard technique for the
kit overdrills 1 mm. However,
because the tarsal bones have
a higher proportion of cancel
lumen of the EndoButton
(Earthrex) was threaded (c).
EndoButton is inserted
into the bone tunnel (d).

Figure 1: Tibialis anterior rupture repair. Intraoperative anteroposterior radiograph identifying appropriate bony insertion site (a). Medial cuneiform is drilled with a 3.2-mm guide pin (b). Previously whip stitched tendon is prepared and
EndoButton (Arthrex, Naples, Florida) is threaded (c). EndoButton is inserted into the bone tunnel (d).
Tibialis anterior tendon repair. The EndoButton (Arthrex, Naples, Florida) is deployed and the distal tendon end is pulled into the bone tunnel (A). EndoButton deployment is confirmed on radiograph with anteroposterior (B) and lateral views with intraoperative fluoroscopy. A Bio-Tenodesis screw (Arthrex) is placed while holding tension to further tighten and augment repair (C). Final repair (D). Final repair confirmed on intraoperative lateral radiograph (E).

Figure 2: Tibialis anterior tendon repair. The EndoButton (Arthrex, Naples, Florida) is deployed and the distal tendon end is pulled into the bone tunnel (A). EndoButton deployment is confirmed on radiograph with anteroposterior (B) and lateral views with intraoperative fluoroscopy. A Bio-Tenodesis screw (Arthrex) is placed while holding tension to further tighten and augment repair (C). Final repair (D). Final repair confirmed on intraoperative lateral radiograph (E).

Figure 3: Illustration of tibialis anterior tendon repair. Anterior view showing starting point for bone tunnel on medial cuneiform (A). Anterior view of repaired tendon (B). Lateral view of the foot with small-diameter bone tunnel through both cortices and larger reamed tunnel ending before far cortex (C). Lateral view of tendon repair (D).

Postoperative Care
Postoperatively, patients were immobilized and non-weight bearing for 6 weeks. After 6 weeks, weight bearing as tolerated in a walking boot for 4 weeks and open chain physical therapy were initiated. At 2 months, regular shoes could be worn and physical therapy continued with impact activities. At 6 months, full activity could be resumed.

RESULTS
There were 6 female patients and 1 male patient with a tibialis anterior rupture (Table). All tibialis anterior ruptures were repaired using a distal biceps repair kit with an EndoButton and/or a Bio-Tenodesis screw. Among the patients with rupture, 4 had comorbidities that could be associated with the rupture (Table). One rupture was traumatic, 2 ruptures were postoperative complications from a prior surgery, and 2 ruptures failed repair by other techniques. The Achilles lengthening procedure using either the Hoke or the Strayer technique was performed in all but 2 cases.

The FAAM was used preoperatively to evaluate patients’ function. The FAAM was administered postoperatively for 1 case because of function prior to surgery. The average follow-up time was 2.1 years. The average FAAM score was 66.1% preoperatively and 87.1% postoperatively ($P=0.002$). No comparative analysis was performed. Further details regarding mechanism of injury and presentation are provided in the Table.

DISCUSSION
Tibialis anterior rupture, a rare injury that is commonly misdiagnosed and presents late, causes significant morbidity. This process was first described in 1905 by Bruning, and no consensus exists regarding treatment. Several techniques have been proposed with reasonable results. Techniques for tendon repair for other tendon injuries have been evaluated thoroughly, including strength comparisons; however, each pathologic condition represents a unique treatment dilemma.

Tendon repair and reconstruction options for the tibialis anterior tendon include direct repair when possible; however, this is rarely possible for chronic tibialis anterior tendon ruptures because of their distal nature. Reconstruction options include direct repair of tendon-tendon, tendon-bone with or without auto/allograft tendon, or tendon substitution with extensor hallucis longus transfer.

No biomechanical studies have been performed comparing repair techniques for the tibialis anterior; however, correlations can be made to the distal biceps, which has had extensive biomechanical testing. The EndoButton has shown superior strength and a higher load to failure than bone tunnel, suture anchor, or interference screw in isolation.

This study showed significant improvement in the FAAM. Limitations of the study included small sample size and lack of a control group. Because tibialis anterior tendon rupture is rare, studies have had small numbers...
### Table: Results of Tibialis Anterior Repair

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age, y</th>
<th>Sex</th>
<th>Weeks to Diagnosis</th>
<th>Mechanism of Injury</th>
<th>Presenting Symptoms</th>
<th>Complications</th>
<th>Surgical Procedure</th>
<th>Follow-up, y</th>
<th>Preop ADL Score</th>
<th>Postop ADL Score</th>
<th>Weeks to Repair Failure</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>77.9/F</td>
<td>59</td>
<td>F</td>
<td>Unknown</td>
<td>Failed tendon repair 5 years prior (suture anchor repair)</td>
<td>Foot drop and frequent tripping</td>
<td>No identifiable injury</td>
<td>Repair to medial calcaneal with EndoButton and Bio-Tenodesis screw (Arthrex)</td>
<td>1.99</td>
<td>93%</td>
<td>100%</td>
<td>4.46</td>
<td>None</td>
</tr>
<tr>
<td>53.0/F</td>
<td>47</td>
<td>F</td>
<td>Chronic instability and pain prior to surgery</td>
<td>Dull pain for a month and mass anterior ankle</td>
<td>Ectopic calcification</td>
<td>Repair to medial calcaneal with EndoButton and Bio-Tenodesis screw (Arthrex)</td>
<td>0.82</td>
<td>70%</td>
<td>94%</td>
<td>4</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>71.3/F</td>
<td>59</td>
<td>F</td>
<td>Chronic rupture</td>
<td>No specific injury</td>
<td>Decreased sensation</td>
<td>Repair with harvest of hamstring tendons for graft</td>
<td>2.27</td>
<td>60%</td>
<td>71%</td>
<td>25</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>53.2/F</td>
<td>47</td>
<td>F</td>
<td>Spring forward</td>
<td>No specific injury</td>
<td>Mass anterior ankle</td>
<td>Repair to medial calcaneal with EndoButton and Bio-Tenodesis screw (Arthrex)</td>
<td>1.87</td>
<td>88%</td>
<td>100%</td>
<td>10</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>57.4/M</td>
<td>45</td>
<td>M</td>
<td>Burning pain while riding a bus</td>
<td>No identifiable injury</td>
<td>Chronic instability</td>
<td>Repair to medial calcaneal with EndoButton and Bio-Tenodesis screw (Arthrex)</td>
<td>0.82</td>
<td>70%</td>
<td>94%</td>
<td>4</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>46.4/F</td>
<td>25</td>
<td>F</td>
<td>Injured during podiatric surgery</td>
<td>Postoperative pain and hyperesthesia anterior ankle</td>
<td>No specific injury</td>
<td>Repair to medial calcaneal with EndoButton and Bio-Tenodesis screw (Arthrex)</td>
<td>2.77</td>
<td>61%</td>
<td>80%</td>
<td>25</td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

**Abbreviations:** ADL, activity of daily living; DM, diabetes mellitus; F, female; FAAM, Foot and Ankle Ability Measure; M, male; OA, osteoarthritis; preop, preoperative; postop, postoperative; TMT, tarsometatarsal.
of patients. The largest study had 19 patients and was not restricted to chronic ruptures. Rare injuries motivate surgeons to use clinical corollaries to aid in the development of treatment methods.

**CONCLUSION**

The authors have presented a technique for tibialis anterior tendon repair using an EndoButton. This has proved to be an effective treatment and is preferred at the authors’ institution. This technique is biomechanically superior in anatomic corollaries. The straightforward method often alleviates the need for tendon graft by using robust pseudo-tendon. This technique would also permit placement of the tendon insertion in the navicular if tendon length was inadequate. Further studies validating this technique are warranted.

**REFERENCES**