Central Strap Gastrocnemius Aponeurosis Turn-Down Flap Reconstruction for Chronic Achilles Tendon Ruptures with Large Defects: A Novel Frontal Plane 180-Degree Rotation Technique for Large Tendon Defects

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Introduction

The Achilles tendon (AT) is the most common tendon torn in the foot and ankle, with a reported rate between 6.0 - 12.0 ruptures per 100,000 people [1,2,3]. When an appropriately sized gap allows, AT ruptures can be repaired primarily with an end-to-end anastomosis. However, large defects and neglected ruptures pose a more difficult challenge. Treatment options in these cases include augmentation with tendon transfers (e.g. flexor hallucis longus (FHL)), allografts, V-Y advancement, fascial turndown flaps, or a combination approach [4,5].

There is scant literature on functional outcomes in neglected AT ruptures. The senior author has previously published his technique for a gastrocnemius aponeurosis turn down flap using medial and lateral straps[6]. Frequently, a central strap is more appropriate due to the width of available aponeurosis. Here, we present a case series and describe a surgical technique utilizing a central strap gastrocnemius aponeurosis turn-down flap for chronic AT ruptures with large defects.

Case Report

Case 1: A 36-year-old male presented with a 5-week-old AT rupture with continued pain and difficulty with ankle plantarflexion. Clinical exam, radiographs and MRI findings confirmed AT rupture. Intraoperatively, a large enthesophyte was found, and after debridement a 7 cm gap remained. A central strap gastrocnemius aponeurosis turn down flap measuring 9 cm in length was elevated and attached to the calcaneus with a double row anchor system and augmented with a FHL transfer. The postoperative course was uneventful, and the patient had 5/5 muscle strength compared to the contralateral limb at one year follow up.

Case 2: A 46-year-old female presented with 4-week history of right calf and AT pain after a running injury. Clinical exam, radiographs and MRI findings confirmed AT rupture. A 6 cm deficit remained after debridement; therefore an 8 cm central strap gastrocnemius aponeurosis turn down flap augmented with an FHL tendon transfer was utilized. The patient had minor wound dehiscence, and remote intermittent tingling and numbness along the L5 dermatome, both of which resolved without issue. The patient had 5/5 muscle strength compared to the contralateral limb at one year follow up.

Case 3: A 47-year-old female presented with posterior calf and AT pain with difficulty ambulating. She recently underwent percutaneous Achilles tenotomy under ultrasound guidance 4 weeks prior, and subsequently re-injured herself. Clinical exam, radiographs and MRI findings confirmed AT rupture. Following debridement, an 8 cm gap remained. A central strap gastrocnemius aponeurosis turn down flap augmented with an FHL tendon transfer was performed. The postoperative course was uneventful, and the patient had 5/5 muscle strength compared to the contralateral limb at one year follow up.

Surgical Technique

This technique has been well described by the senior author[6]. A lazy-S Incision is placed over the posterior lower leg and AT. Dissection is carried to the paratenon which is incised proximal to the rupture site and carefully reflected off the AT. Degenerated tissue is then debrided. The tendon gap measurement is taken with the knee slightly flexed and ankle in 20 degrees of plantarflexion.

A central gastrocnemius strap is created for the turn-down flap. Flap measurement begins 2 cm proximal to the distal end of the proximal stump, with the initial 2 cm segment as the axis in which the flap will rotate. An additional 2 cm is added to the tendon gap to obtain final flap length, i.e a 6 cm deficit would require a 8 cm flap. It is good practice to err on the side of creating a longer flap. Debridement of excess flap as needed. The flap width proximally is determined by the width of the distal end of the proximal stump. A slight angle at the distal aspect of one arm of the flap is created to allow for flap rotation.

The flap is created centrally in the aponeurosis **(Figure 1)**, which is incised full thickness to the level of soleus muscle and elevated from proximal to distal utilizing electrocautery. The flap is then rotated 180 degrees about the axis point such that the anterior gliding surface of the aponeurosis remains anterior **(Figure 2)**. The flap is secured at the axis point with suture. The aponeurosis harvest site is re-approximated with absorbable suture. **(Figure 3)** An FHL tendon transfer is performed at this time. **(Figure 4).** The flap is then secured to the remaining distal stump of Achilles tendon with a Krakow or Kessler stitch or to the posterior calcaneus with the surgeons preferred anchor system. The flap should be secured with the knee slightly flexed, and the ankle held in approximately 20 degrees of plantarflexion **(Figure 5)**. The paratenon is repaired and the surgical site is closed in layers **(Figure 6)**.

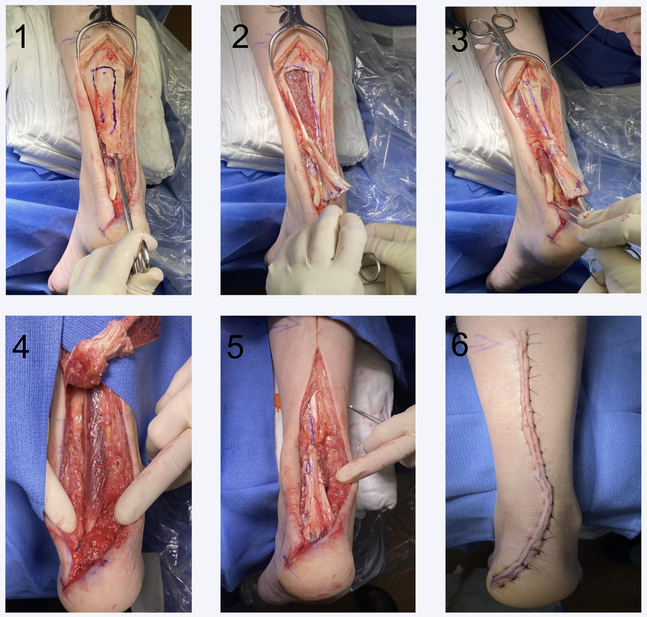

Figure 1: Central aponeurosis flap is marked on the proximal aponeurosis prior to elevation.
Figure 2: The flap is elevated from the underlying soleus muscle belly and rotated 180-degrees while preserving the frontal plane orientation of the aponeurosis.
Figure 3: Re-approximation of flap site and securing of the graft pivot point.
Figure 4: FHL transfer augmentation
Figure 5: Final Gastrocnemius aponeurosis turn-down flap Achilles repair with double row knotless anchor fixation into the calcaneus.
Figure 6: Final closure

Results

	Gap Length (cm)	Flap Length (cm)	AOFAS Score	Circumference at Insertion (cm)	Circumference 5 cm Proximal to insertion (cm)	Circumference 10 cm Proximal to Insertion (cm)
Case 1	7	9	98/100	23.5 (+0)	24.0 (+1.0)	28.8 (+0.8)
Case 2	6	8	87/100	23.0 (+0.1)	23.7 (-0.3)	28 (+1.0)
Case 3	8	10	95/100	25.5 (+0)	25.0 (+0)	27.2 (-0.4)

Table 1: Table depicting the intraoperative gap length, the length of the central strap flap created, AOFAS score, and the circumference of the operative extremity at various levels with the size difference compared to the non-operative extremity in parentheses. Of note, the plantarflexion strength was 5/5 for the operative and nonoperative lower extremities.

Discussion

There is a paucity of literature describing gastrocnemius turndown flaps for chronic AT ruptures. Sanada et al. assessed 56 patients after a similar gastrocnemius turndown flap for a chronic AT ruptures. However, their flap was oriented with the posterior gliding surface of the tendon facing anteriorly, contrary to our technique. Barring two re-ruptures, their remaining patients had strong outcomes, and their athletic patients returned to prior level of play [7]. Our study found adequate strength, high AOFAS scores, and no re-ruptures or revision surgery with the central strap gastrocnemius aponeurosis flap with FHL transfer for chronic AT ruptures one year post operatively.

An isolated FHL tendon transfer may be appropriate in lower demand patients; however, flap augmentation provides additional benefit. A systematic review by Apinum et al. found superior AOFAS hindfoot scores when augmentation was added to the FHL transfer [8]. Multiple studies have found isolated FHL transfers provide insufficient repair, hence the utilization of this flap in our case study.

One concern with a turndown flap is bulk at the turn-down site. We have not found this to be an issue in our practice. Yang et al. compared a direct end-to-end repair with a direct end-to-end repair with gastrocnemius turn down straps superimposed overtop the repair in acute AT ruptures. There were no differences found in any strength, pain, cosmesis, or functional outcomes[9]. Our results showed variable calf circumference at final follow up. At five centimeters proximal to the ankle, one patient's operative AT was larger, one was smaller, and one was the same size as the contralateral side. At ten centimeters proximal to the ankle, two patient's operative AT were larger, and one was smaller. No patient had an operative side measurement greater than 1.0 centimeter difference compared to the non-operative side. Sanada et al. found the average difference in circumference compared to the contralateral limb was 1.3 cm at 6 months postoperative [7].

The senior authors previous study describes a medial and lateral strap gastrocnemius flap which recommends harvesting approximately 4 additional centimeters of tendinous flap material to account for the crossover, stability, and suturing [6]. The two-strap technique is appropriate for patients with a wide gastrocnemius aponeurosis near the crossover site. Ideal flaps are at least one centimeter in width, so a single flap technique should be considered in narrower aponeuroses.

Our recommendation for creating a curve at the distal end of the flap allows the surgeon to rotate the flap 180 degrees, maintaining the gliding surface of the tendon posteriorly. We employ this technique as it preserves the anatomic orientation of the AT, potentially preventing adhesions and maintaining additional vascularity to an area with known wound healing complications.

In conclusion, functional capabilities and strength were preserved, and bulk at the turn-down site was not significantly increased in our case study. We propose this advanced AT reconstruction technique with FHL transfer is suitable for high functional demand patients with chronic Achilles tendon ruptures with large deficits.

References

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