



Two-Incision, Wire-Assisted Achilles Tendon Z-Lengthening: Surgical Technique and Case Report

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ABSTRACT

Achilles tendon lengthening is an important surgical procedure to manage gastrocnemius-soleus complex contracture. Because the Achilles tendon fibers twist like Manila rope and torsion varies widely, it is very difficult for any current lengthening procedure to be performed that accurately follows the rotation of the fibers; thus, irregular sliding or repeated cutting of the fibers may result. We present a patient with Achilles tendon contracture in whom the tendon was divided coronally along the twisted fibers using a stainless-steel wire before hemisection for Z-lengthening; thus, hemisection could be performed not only with minimal invasion but also accurately. After tendon lengthening, ankle function was restored to near normal. After a 15-month follow-up time, improvement of ankle function was well maintained, and no complication, such as crouch gait, was observed. We believe this was owed to accurate division of the tendon fibers before lengthening, preservation of the paratenon and deep fascial tube, and the use of Z-lengthening.

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Achilles tendon lengthening (ATL) is usually performed in patients with gastrocnemius-soleus complex contracture and aims to restore ankle dorsiflexion. Because the Achilles tendon fibers are twisted from 11° to 65° (1), it is almost impossible for traditional Z-lengthening to section the fibers accurately without cutting them twice. We describe a novel ATL technique using a wire to divide the twisted fibers longitudinally for accurate section before Z-lengthening.

Case Report

A 24-year-old male had claudication with Achilles tendon tightness for 20 years. The claudication gravitated over the next 3 years. Passive ankle dorsiflexion was evaluated with the knee flexed and extended. The left ankle could not reach 5° with either knee position.

The patient was placed in a prone position under general anesthesia. After sterilization and draping, exsanguination was performed on the affected limb to reduce bleeding. The first transverse skin incision was placed over the tendon ~2 to 3 cm proximal to the Achilles tendon insertion, and the second was made 6.5 cm proximal from the first incision. Both incisions were ~2 cm long and along the skin creases. Skin and fascia were incised with care to avoid an inadvertent transverse cut

of the tendon underneath. The paratenon was carefully incised along the skin incision line until the lateral and medial borders of the Achilles tendon were exposed. Two hemostats were passed through the incisions underneath the tendon to hold them up (Fig. 1A).

In the proximal transverse incision, a stainless steel wire (M660; Ethicon, Inc., Somerville, NJ, USA) was passed through the coronal half of the tendon using the attached needle (Fig. 1B). Using the wire, the fibers of the tendon were divided into anterior and posterior halves at the level of the proximal transverse incision (Fig. 1C). The wire was lifted up and a second wire was passed through as a cutting wire (Fig. 1C).

A long hemostat was inserted from the distal incision and passed beneath the skin bridge between the 2 incisions to hold the 2 ends of the cutting wire (Fig. 1D). Caution was taken to pass the hemostat over the tendon but inside the tendon sheath. Both ends of the wire were then pulled out from the distal incision. Both ends of the wire were held firmly and pulled as if using a wire saw to divide the fibers of the Achilles tendon from proximal to distal between the 2 incisions (Fig. 1E). When the tendon was separated using the wire to the level of the distal incision, we found that the division of the tendon rotated laterally compared to the proximal level (Fig. 2A).

The 2 wires were lifted up. The anterior half of the tendon was cut transversely at the level of proximal incision after stay sutures were placed in the distal free end (Fig. 2B–D); the superficial half of the tendon was cut transversely at distal incision level after stay sutures were placed in the proximal free end (Fig. 2C–E).

The ankle was gently dorsiflexed with the knee held in extension and 20–30 mm slide lengthening of the Achilles tendon was achieved (Fig. 2F). The lengthened Achilles tendon was anchored with the stay sutures

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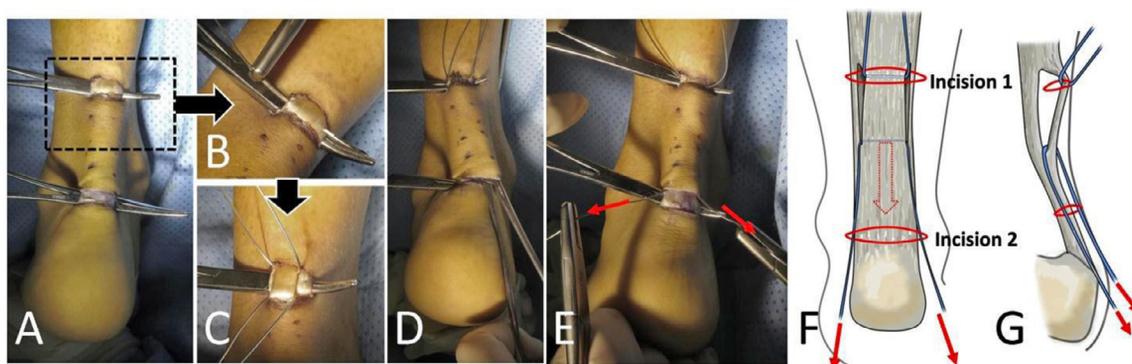


Fig. 1. Division of Achilles tendon fibers using a wire through 2 transverse incisions. (A) Two transverse incisions were made to expose the Achilles tendon. (B, C) A stainless-steel wire was passed through the coronal half of the tendon using the attached needle. (D) A long hemostat was inserted from the distal incision and passed beneath the skin bridge between the 2 incisions to hold the 2 ends of the cutting wire. (E) Both ends of the wire were held firmly and pulled (as when using a wire saw) to divide the fibers of the Achilles tendon from proximal to distal between the 2 incisions. (F, G) Illustrations of the Achilles tendon division procedure using a wire.

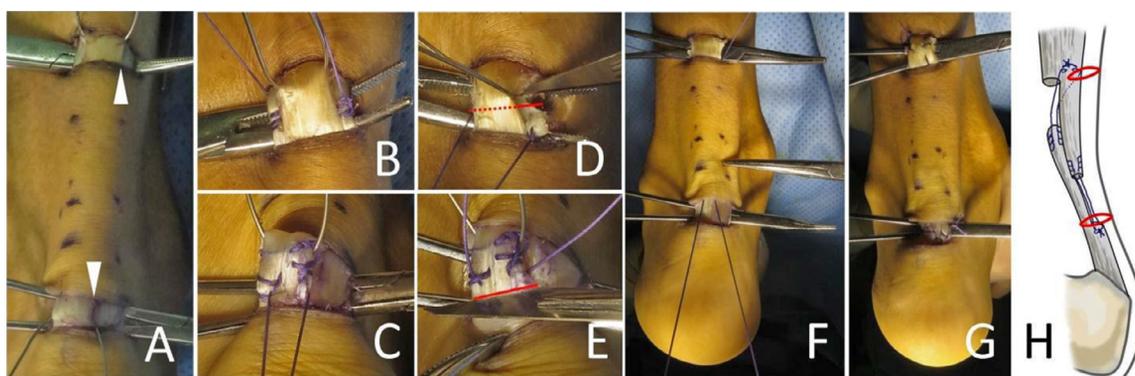


Fig. 2. Extension and fixation of the Achilles tendon using a wire. (A) Two transverse incisions were made to expose the Achilles tendon. White arrowheads indicate the division line of the tendon fibers, which indicates the torsion of the tendon fibers. (B, D) The anterior half of the tendon was transversely cut at the level of the proximal incision after stay sutures were placed in the distal free end. (C, E) The superficial half of the tendon was transversely cut at the level of the distal incision after stay sutures were placed in the proximal free end. (F) The Achilles tendon was lengthened. (G) The position of the lengthened Achilles tendon was anchored with the stay sutures. (H) Illustrations of the extension and fixation method of the Achilles tendon.



Fig. 3. The 2 transverse incisions made for the ATL. (A) Intraoperative image of the incisions. (B) Incisions 3 months postoperatively.

(Fig. 2G and H). After careful hemostasis, the incision was closed in layers (Fig. 3A). The duration of surgery was ~60 minutes. Postoperatively, a short leg cast was applied with the ankle in a neutral position. The cast was removed after 4 weeks. Gentle active and passive ankle dorsiflexion and heel lifting exercises were performed gradually after immobilization.

After a follow-up time of 15 months, both incisions had healed well (Fig. 3B), and the improvement in dorsiflexion was 28°. The patient's gait pattern was improved and he had no complications such as tendon adhesion, total transection, excessive lengthening (calcaneus

deformity), or neurovascular damage. He provided informed consent for data concerning the case to be submitted for publication.

Discussion

ATL is an important surgical procedure to manage gastrocnemius-soleus complex contracture. Several methods have been used commonly for tendon lengthening, including the percutaneous procedure (2,3), sliding (4–6), and Z-lengthening (7,8). However, the Achilles tendon fibers twist like Manila rope (9) and torsion varies widely (1). It is very difficult for any current lengthening procedure to be performed that accurately follows the rotation of the fibers; thus, irregular sliding or repeated cutting of the fibers may result (10). A cadaver study showed that 21 of the 60 triple hemisections for ATL failed owing to inaccurate cutting of the twisted fibers (11). Because rotation of the tendon is unpredictable, it would be possible to use a wire to separate the tendon fibers all the way along the rotation, rather than estimate the rotation angle roughly. We present a patient with Achilles tendon contracture in whom the tendon was divided coronally along the twisted fibers using a stainless-steel wire before hemisection for Z-plasty. Thus, hemisection could be performed not only with minimal invasion, but also accurately. As the tendon fibers were divided clearly by the wire, the amount of lengthening could be well controlled, avoiding any uncut fibers or twice cutting any fiber and ensuring a low risk of overlengthening and rupture. This is difficult to do during percutaneous tendon lengthening. To our knowledge, this technique has not been described previously in the English literature.

The arteries of the Achilles tendon and its paratenon are oriented in 3 directions: longitudinal, transverse, and deep. The majority of the larger arterial branches run over the posterior surface of the tendon transversely and vertically to the tendon fibers (12–14). Both of our incisions were made transversely along natural skin creases, so that the arterial branches across the tendon surface were protected compared with the traditional longitudinal incision.

At least 2 cm of overlap of the 2 strips of Achilles tendon was ensured after adequate correction in this case. Each free end of the strip was hung to the opposite strip at the incision level with firm sutures. Because the paratenon sheath and deep fascial tube around the overlap remained intact between the 2 incisions, the healing potential of the tendon was ensured as much as possible, which avoided delayed healing with possible rupture and adhesions.

After tendon lengthening, ankle function was restored to near normal. After a 15-month follow-up time, improvement of ankle function was well maintained and no complication, such as crouch gait, was observed. We believe this was due to accurate division of the tendon fibers before lengthening, preservation of the paratenon and deep fascial tube, and the use of Z-lengthening.

Despite the rationality and good early results of the novel technique, it remains difficult to draw conclusions from this single case. Evaluation of functional recovery also was limited. This pilot study demonstrated the feasibility and effectiveness of the mini-invasive wire-assisted Z-lengthening technique. Randomized controlled studies with large case numbers and longer follow-up duration are required to confirm the advantage and effectiveness of the wire-assisted lengthening procedure.

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