The Journal of Foot & Ankle Surgery 58 (2019) 766–770

Contents lists available at ScienceDirect

The Journal of Foot & Ankle Surgery

journal homepage: www.jfas.org

Arthroscopic Lengthening of the Flexor Hallucis Longus Tendon to Correct Hallux Flexion Deformity

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ARTICLE INFO

Level of Clinical Evidence: 4

Keywords:
arthroscope
foot deformity
hallux dysfunction
lengthening of tendon
tendon contracture

ABSTRACT

Contracture of the flexor hallucis longus (FHL) tendon is one of the most common factors leading to hallux flexion deformity. Few cases treated by arthroscopic technology have been reported. In this article, we perform a new method to lengthen the FHL tendon under an arthroscope. We present a case of 1 patient treated with this technique and followed for 2 years. The appearance of his halluces remarkably improved at the follow-up visits, and movement was refined simultaneously. From the satisfactory effect of this operation, lengthening the FHL tendon under arthroscope is an effective method to correct flexion deformity of the hallux with minimal incisions. This technique also provides an innovative application of minimally invasive surgeries to treat clinically infrequent diseases.

Contracture of the flexor hallucis longus (FHL) tendon, resulting in a painful flexion deformity of the halluces, is a common complication following free fibula flap transfer and serious traumas such as injury of the peroneal tendon or the peroneal nerve (1). Acquired clawed toe, which is characterized by hyperextension of the metatarsophalangeal joint and flexion of the interphalangeal joint (IPJ) (2), would not be considered unrelated to the contracture of the FHL (3). Congenital curly toe, post-poliomyelitis clawing of the hallux, toe contracture caused by diabetes, and dysfunction of the hallux and lesser toes secondary to traumas are all comprised in the disorders of the hallux. Several techniques have been reported (4–6) to treat the clawing of the great toe (the Jones procedure or one of its modifications, the FHL transfer technique, flexor tenotomy, etc) (7). But there is little research about arthroscopic methods to release the FHL. We proposed a new method to arthroscopically release the contracture of the FHL.

We report the case of a patient who received this procedure and the satisfactory outcome of the improved hallux function at follow-up visits. This technical note summarizes the surgical procedure and offers a step-by-step guide to perform it.

Case Report

The patient was a 26-year-old male. He experienced a serious accident with tibia and fibula fractures in the left limb and received wound debridement, fracture repositioning and fixation, and open decompression for osteofascial compartment. His severe trauma ultimately led to hallux malformation and dysfunction. By comparision with the contralateral IPJ, we found the great toe's IPJ of the left foot was excessively flexed, resulting in inconvenience or discomfort in daily activities when wearing shoes or walking. The function was severely damaged, and his daily life was affected after the trauma; thus, we performed the following treatment for him.

Step 1: Preoperative Estimating

Preoperative physical examination is a reliable means to measure the motion of the great toe and the degree of contracture, which could indirectly provide therapeutic clues to treat this deformity. The general condition of the toes, foot, and ankle should be estimated carefully. If the limited movement of the toe was caused by neurological factors, consideration should be given to the utility of this method.

Step 2: Position and the Portals

The patient was set in the prone position and fixed on the operating table after epidural anesthesia. An electric tourniquet was attached in the left thigh root. Standard posteromedial and posterolateral approaches were made with a 2.7-mm 30° arthroscope (8). The posterolateral portal was located beside the Achilles tendon, above the

Financial Disclosure: None reported.
Conflict of Interest: None reported.
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https://doi.org/10.1053/j.jfas.2018.11.012

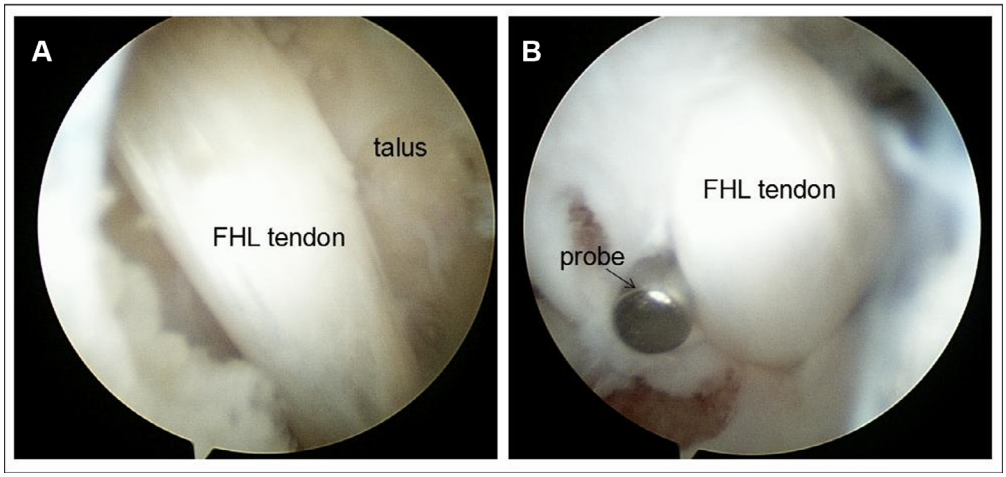

Fig. 1. The flexor hallucis longus tendon after posterior ankle debridement. The tendon's tension was estimated by probing it (*A*) and bending and stretching the hallux (*B*).

connecting line of the external ankle to the tendon. The posteromedial portal was at the same level, beside the medial of the Achilles tendon. The lateral auxiliary incision was made under the arthroscope with the guidance of a lumbar spinal needle. This auxiliary incision could be established above or below the posterolateral portal mentioned earlier.

Step 3: Tendon Extension

First, debridement was performed to obtain a clear view. Second, the tension of the FHL tendon was probed and evaluated for tensile force (Fig. 1). Then 2 lumbar puncture needles were used to fix the proximal and the distal of the tendon, incising the tendon longitudinally with a sharp blade between the 2 needles for 2 cm (Fig. 2). The hallux could be dorsiflexed intermittently to provide tension of the tendon, to expose the proximal end, and to advance the cut more proximally in the process. The tendon was separated into 2 bundles, then the bundles in the proximal and the distal ends were cut off like a Z-type extension. When the ankle was located in a neutral position and the great toe was passively extended, the 2 bundles were overlapped ~1 cm with a lumbar puncture needle running through a polydioxanone line (Ethicon, Somerville, NJ) in both the proximal and the distal of the overlap. The polydioxanone line was threaded back with a grasping forceps, then a slip knot with a locking mechanism (9) was tied under an arthroscope (Fig. 3).

Step 4: Assessment

When the lengthening was completed, the motion of the FHL tendon was checked (Fig. 4). If its activity was affected by the talus, a more extensive debridement such as cleaning up the soft tissue or removing the osteophytes of the talus was needed. If the sutured tendon lacked continuity or the proximal tendon could not absolutely move along with the distal part when the great toe was passively flexed or extended, another suture would be required to reinforce the tendon ends. In other words, it is important to ensure that the sutured tendon is firm and has no resistance to movement. Finally, repeated articular cavity irrigation was performed with sterile normal saline to avoid infection.

Rehabilitation Therapy and Result

After the surgery, the foot was immobilized in a neutral position with a plasterboard or a brace for 6 weeks. The sutures were taken out 2 weeks after the operation, then partial weightbearing was allowed as tolerated for 4 weeks in crutches or a walking frame. Ankle pump training and elastic tape stretching training were carried out alternately after 6 weeks. Full weightbearing was permitted without protection gradually after 8 weeks. Exercises of the great toe and lesser toes continued during rehabilitation. Follow-up examinations were performed at

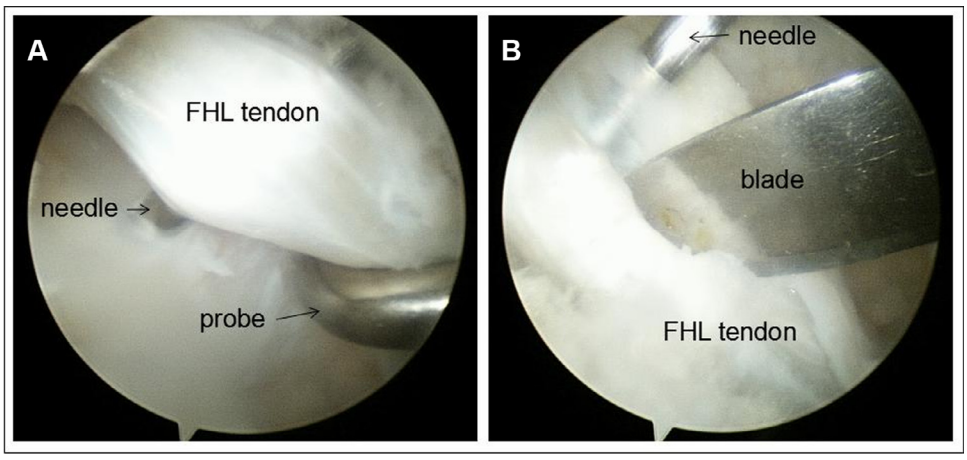

Fig. 2. Using 2 needles to fix the tendon (*A*) and longitudinally cut ~2 cm along the middle line (*B*).

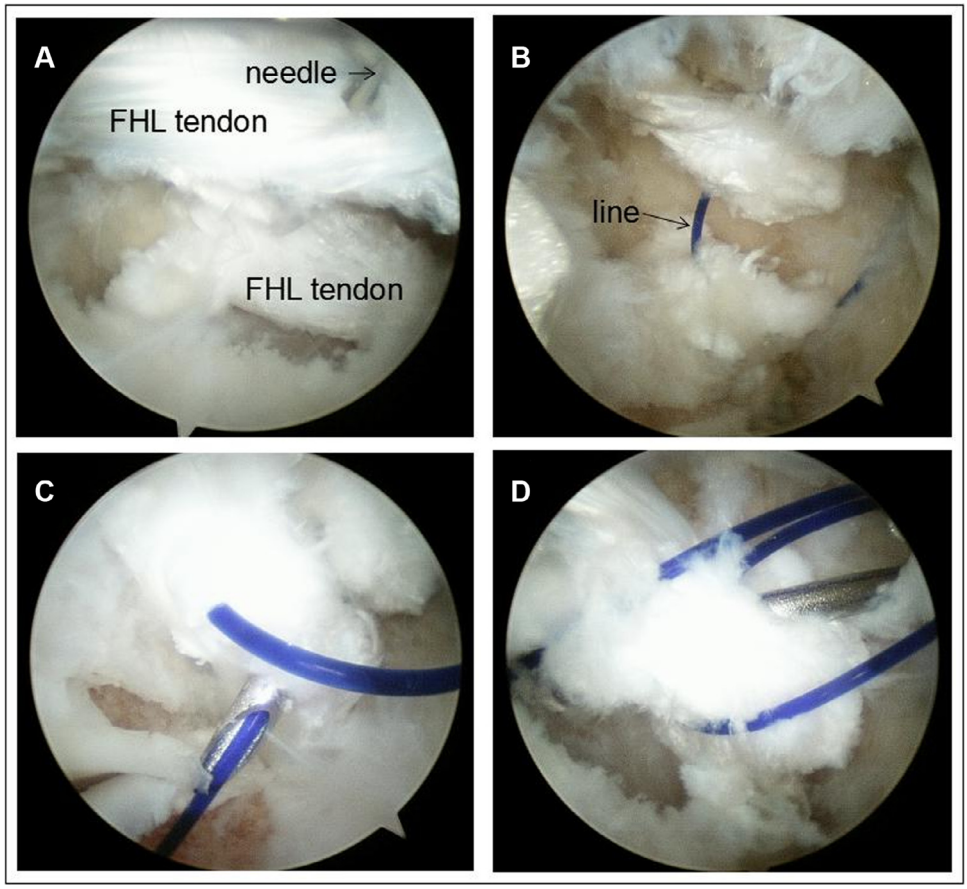

Fig. 3. The tendon was Z-type lengthened (*A*) and sutured with a polydioxanone line (*B–D*).

4 weeks, 6 weeks, 8 weeks, 6 months, 1 year, and 2 years postoperatively. The contracture appearance of hallux improved after the operation. In terms of function, the mobility of the big toe was also better than that before surgery. It became more flexible and had a wider range of motion (Fig. 5). Walking or wearing shoes became easier and more comfortable. The patient was satisfied with the therapeutic effects at the final follow-up visit.

Discussion

Hallux flexion deformity is clinically manifested as flexion contracture at the IPJ, and the flexion or extension of the first toe is restricted severely. Our method of tendon lengthening under the arthroscope can be used effectively to correct the deformity and facilitate the movement of the hallux. Arthroscopic surgeries are characterized by reduced

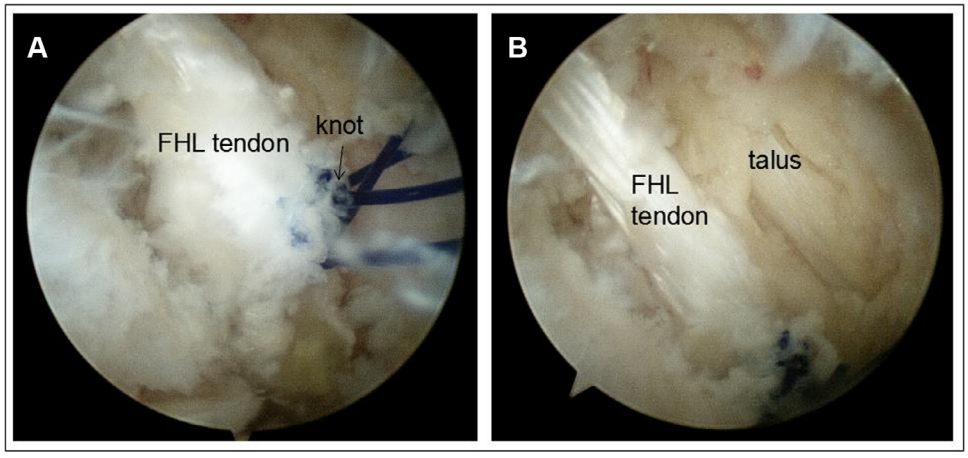

Fig. 4. Tightening the ends of the line (*A*). The appearance of the extended tendon and residue were repeatedly debrided (*B*).

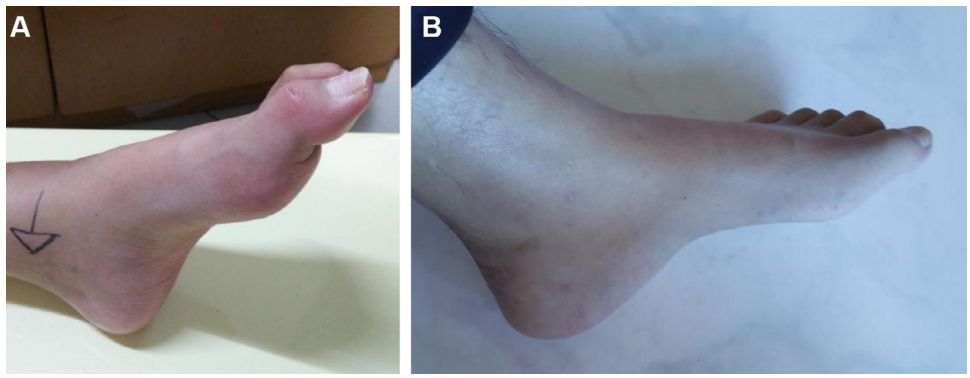

Fig. 5. Before surgery, the hallux was in a constant state of flexion, the big toe could not extend or move freely (A); During postoperative follow-up, the contracture appearance was significantly improved and the activity was significantly improved (B).

trauma, scarring, and postoperative pain. Arthoscopy has the advantages of minimal overall morbidity and earlier return to activities (10). The literature related to arthroscopic tendon lengthening is not abundant. Using this technique might be a significant attempt and supplement to the literature.

Lengthening of the tendon is commonly used for tendon contracture. It has been widely used in the Achilles tendon to correct stroke-related foot and ankle deformity, equinus deformity, or Achilles contracture syndrome (11). Z-plasty or lengthening of the tendon is characterized by a median longitudinal cut along the long axis of the tendon and a transverse cut to the proximal and distal ends of the tendon in opposite directions (12). Lee et al (13) reported the satisfactory outcome of Z-plasty of the FHL tendon at the tarsal tunnel. In their study, 8 patients received open incisions along the tarsal tunnel; 3 cm of the FHL tendon was exposed in each case and extended by a mean of 1.7 cm. In our study, the tendon was lengthened by only 1 cm. This difference is likely because the contracture severity of the tendons varied in the different cases or perhaps because of measurement error. In any case, the extended length of the tendon should be based on the position of the ends when the toe is passively extended.

In 2007, a cadaver study of endoscopic FHL decompression was reported (14). Based on that study, reducing the pressure of the FHL under the arthroscope could be done. Cutting or lengthening of the FHL could obtain a satisfying release of digital flexion deformities that happen behind the graft (15). Another study (16) put forward an operative technique for modified arthroscopic release of the FHL tendon sheath. In the FHL transfer technique, the sheath was identified and incised, then its partial distal attachment was cut and transferred to the distal phalanx. A related study (3) suggested that the FHL tendon transfer created high patient satisfaction compared with the other procedures. All methods mentioned earlier should take the quality of the bone into account, especially of the metatarsal and the phalanx. For this aspect, the technique we present has a relative advantage. For patients who have undergone serious trauma, soft tissue or other structures become disordered and easily injured, so a minimally invasive operation, rather than an opening one, is more appropriate.

This technique also has its limitations. First, its clinical application is restricted, and choosing the operation should be done with caution when the FHL tendon is atrophied or its texture is not ideal. Second, the working space under arthroscopy is not very large, and considering the neighboring structures, there is risk of vessel and nerve injury. Third, this procedure could be used to improve function of the injured limbs or halluces, but other therapies are also needed to treat primary injuries, especially for seriously injured patients. In addition, we have not treated cases such as congenital deformity, post-poliomyelitis, or diabetes-caused contracture, and the technique's therapeutic effect under those circumstances is still uncertain. Last, no other cases have been treated with the technique, so many more cases with long-term follow-up terms are needed to evaluate its therapeutic effect. In the case of serious deformity of the clawed hallux, treatment of the metatarsophalangeal joint or the IPJ is required and should be analyzed comprehensively as well. Overall, for the patient with FHL tendon contracture and clawed hallux deformity, this technique could be applied especially when depressing the sheath or releasing the tendon cannot achieve a satisfactory effect.

In conclusion, we found arthroscopic extension of the FHL to be a minimally invasive surgical procedure that released the contracture tendon and thus corrected the flexion deformity of the hallux. We believe that this technique is applicable in situations of contracture of the FHL tendon after severe trauma, although we realize that further research is needed to compare it with other methods and gain a better understanding of its applicability in clinical practice.

Acknowledgments

The authors thank the patients and staff involved in this study for their time and work.

Supplementary Materials

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1053/j.jfas.2018.11.012.

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