



## ENDOSCOPIC FLEXOR HALLUCIS LONGUS TENDON TRANSFER IN TREATMENT OF ACHILES TENDON RUPTURE

### ENDOSKOPSKO PREMJEŠTANJE TETIVE FLEKSOR HALLUCIS LONGUSA U LIJEČENJU RUPTURE AHILOVE TETIVE

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Cite as: Klobučar H, Klobučar D, Tršek D. Endoscopic flexor hallucis longus tendon transfer in treatment of achilles tendon rupture. *Croat Sports Med J.* 2025; 40(1):59-65.

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DOI: 10.69589/hsv.40.1.6

#### ABSTRACT

Treatment of acute and chronic Achilles tendon ruptures is controversial topic. Non operative treatment does not provide full Achilles tendon strength. Many different options for surgical treatment exists; open direct suturing of tendon, augmentation with fascia flap or adjacent tendons of peroneus brevis (PBT) or flexor hallucis longus tendon (FHL) and percutaneous reconstruction. Treatment of athletes urges confident method, minimally invasive approach and option that allows quick and full recovery with good tendon strength.

We describe endoscopic flexor hallucis longus tendon (FHLT) transfer on calcaneal tuber and fixation with interference screw and Endobutton. Sixteen patients were operated on by a senior surgeon. There were 14 men and 2 women, average age 53 years (30-74 years, median 58 years). Six patients were operated on due to acute Achilles tendon rupture with mean period from rupture to surgery of 12 days (3-28 days, median 12 days) In 10 patients ruptures were chronic with mean period from injury to surgery of 14 months (6 weeks to 48 months, median 5 months). FADI and AOFAS scores were evaluated before and six months after surgery and MRI was performed before and at least one year after surgery.

The mean preoperative FADI<sub>1</sub> was 49 (34-62, median 51), and the postoperative FADI<sub>2</sub> was 81 (43-100, median 100). The preoperative AOFAS<sub>1</sub> was 60 (51-79, median 68), and the postoperative AOFAS<sub>2</sub> was 92 (76-100, median 100). Complications were; breakage of interference screw in one patient and Endobutton plate irritation in one patient. All

#### SAŽETAK

Liječenje akutnih i kroničnih ruptura Ahilove tetive kontroverzna je tema. Neoperativno liječenje ne osigurava punu snagu Ahilove tetive. Postoji mnogo različitih opcija za kirurško liječenje; otvoreno izravno šivanje tetive, augmentacija fascijalnim režnjem ili susjednim tetivama peroneusa brevis (PBT) ili tetive flexor hallucis longusa (FHL) te perkutane rekonstrukcije. U liječenju sportaša potrebno je primijeniti pouzdanu metodu, minimalno invazivan pristup i opciju koja omogućuje brz i potpun oporavak uz dobru čvrstoću tetive.

Opisujemo endoskopski prijenos tetive flexor hallucis longus (FHLT) na tuber petne kosti uz fiksaciju interferentnim vijkom i endobutonom. Šesnaest bolesnika operirao je prvi autor. Bilo je 14 muškaraca i 2 žene, prosječne životne dobi 53 godine (30-74 godine, medijan 58 godina). Šest pacijenata je operirano zbog akutne rupture Ahilove tetive s prosječnim razdobljem od rupture do operacije od 12 dana (3-28 dana, medijan 12 dana). U 10 bolesnika rupturu su bile kronične s prosječnim razdobljem od ozljede do operacije od 14 mjeseci (od 6 tjedana do 48 mjeseci, medijan 5 mjeseci). Rezultati FADI i AOFAS procijenjeni su prije i šest mjeseci nakon operacije, a MRI je učinjen prije i najmanje godinu dana nakon operacije.

Prosječni prijeoperacijski FADI<sub>1</sub> bio je 49 (34-62, medijan 51), a postoperativni FADI<sub>2</sub> bio je 81 (43-100, medijan 100). Prijeoperacijski AOFAS<sub>1</sub> iznosio je 60 (51-79, medijan 68), a postoperativni AOFAS<sub>2</sub> 92 (76-100, medijan 100). Komplikacije su bile; pucanje interferentnog vijka u jednog pacijenta i iritacija endobuton pločicom u jednog

patients had improvement in the functional clinical status and they all returned to their preferred previous recreational sport activities. In all patients we found hypertrophy of FHL and homogeneous MRI image of Achilles tendon structure one year after surgery.

Endoscopic FHLT transfer on calcaneal tuber is simple and reliable method for Achilles tendon function restoration in athletes with a predictable expected treatment outcome.

**Keywords:** *endoscopic flexor hallucis longus tendon transfer, Achilles tendon rupture, endoscopic Achilles tendon reconstruction*

## INTRODUCTION

Achilles tendon (AT) rupture is a serious problem for any athlete(23). It is the strongest and dominant tendon for foot function, especially during activities such as running, jumping, landing, and exercising on uneven surfaces (35). Non-surgical treatment requires long-term immobilization and recovery and cannot safely restore full strength to the damaged tendon (5). That is why we opt for surgical treatment in athletes. In acute ruptures, we opt for end-to-end suturing of the ruptured ends of the tendon. There are several techniques, from open to minimally invasive (8). There is no generally accepted consensus on when to apply which technique (5). If the Achilles tendon ruptures in the myotendinous part, the procedure of suturing the tendon through the muscle structure is objectively difficult to perform. Also, if the rupture is present in the central part of the tendon, and if the tendon is more degeneratively changed, suturing the tendon may be difficult, i.e. it is necessary to expand the surgical incision and cover a large part of the tendon with sutures. A large surgical incision poses a risk of tissue healing and complications of the surgical wound. These are situations when augmentation of the damaged Achilles tendon can be considered. Chronic ruptures of the Achilles tendon should not be seen in active athletes. They are defined as ruptures that have not been treated for a period of at least six weeks after the rupture. Chronic ruptures are most often characterized by diastasis of the ends of the ruptured tendon and degenerative changes in the tendon tissue. Surgical solutions for such ruptures require procedures that can bridge tendon defects (Figure 1) (9). Turndown flap or tendon flap methods utilize the proximal aponeurotic and tendon tissue of the Achilles tendon (Figure 1)(28). Surrounding tendons can be used (flexor hallucis longus – FHL, peroneus brevis – PB or autologous gracilis graft)(2). Biomechanical studies of extrinsic foot muscles have shown that the tendons of the medial side of the foot have a more favorable synergistic effect on the Achilles tendon than the peroneal tendons(15, 24, 33). Given the importance and role of the tibialis

pacijenta. Svi pacijenti su imali poboljšanje funkcionalnog kliničkog statusa i svi su se vratili svojim prijašnjim rekreativnim sportskim aktivnostima. Kod svih pacijenata godinu dana nakon operacije nalazimo hipertrofiju FHL-a i homogenu MR sliku strukture Ahilove tetive.

Endoskopski prijenos FHLT-e na tuber petne kosti jednostavna je i pouzdana metoda za obnovu funkcije Ahilove tetive kod sportaša s predvidljivim očekivanim ishodom liječenja.

**Ključne riječi:** *endoskopski prijenos tetive flektor halucis longusa, ruptura Ahilove tetive, endoskopska rekonstrukcija Ahilove tetive*

posterior tendon, the choice of the flexor hallucis longus tendon (FHLT) is ideal for augmentation (Figure 1C)(3). This muscle has an ideal direction of activity, the tendon is stronger than the others in the area, it has the ability to adapt and bringing the muscle belly closer to the Achilles tendon improves vascularity in the degenerated area. Utilization of the FHL does not significantly reduce the flexibility and strength of the thumb, since this function is taken over by the flexor digitorum longus tendons (30). Endoscopic Achilles tendon augmentation with FHLT stimulates tendon healing in a closed environment, with minimal trauma to already damaged tissue (5, 6, 10-12, 16, 20, 21, 32). In this

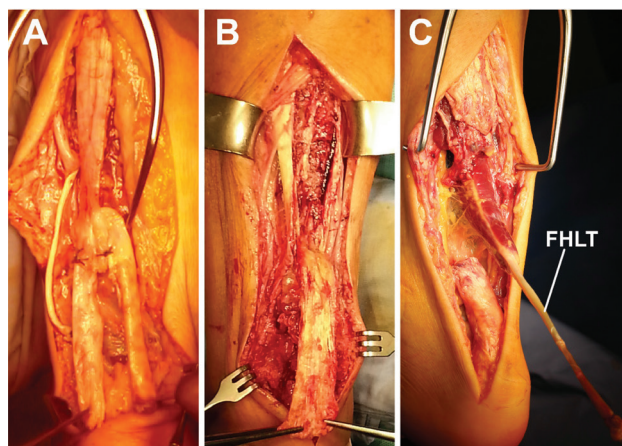


Figure 1. Different open surgical methods for augmentation of chronic ruptured Achilles tendon. A – double turn-down flaps made from proximal Achilles myotendinous aponeurosis. B – one wide turn-down flap from Achilles aponeurosis. C- open utilisation of flexor hallucis longus tendon (FHLT) for bridging the Achilles tendon defect.

Slika 1. Različite otvorene kirurške metode augmentacije kronične rupture Ahilove tetive. A – dvostruki zaokretni režnjevi od proksimalne Ahilove mišićnotetivne aponeuroze. B – jedan široki zaokretni režanj od Ahilove aponeuroze. C- otvorena upotreba tetive flexor hallucis longus (FHLT) za nadomještanje defekta Ahilove tetive.

paper, we present the possibilities of endoscopic transfer of the FHLT to the calcaneal tuber for augmentation of the ruptured Achilles tendon.

## PATIENTS AND METHODS

During a period of six years, first author performed 16 procedures in 15 patients. There were 14 men and 2 women, average age 53 years (30-74 years, median 58 years). Six patients were operated on due to acute Achilles tendon rupture with mean period from rupture to surgery of 12 days (3-28 days, median 12 days). In 10 patients ruptures were chronic with mean period from injury to surgery of 14 months (6 weeks to 48 months, median 5 months). All patients have a history of a specific type of physical activity during which they sustained an Achilles tendon injury. The clinical findings are dominated by weakness in bipodal standing and inability to raise the injured leg on the toes in monopodal standing. A defect at the site of Achilles tendon rupture or decreased tendon tone is palpated. Thompson and Matis signs are positive. Scores (Foot and Ankle Dissability Index – FADI and American Orthopaedic Foot and Ankle Score – AOFAS) were evaluated before surgery (FADI<sub>1</sub>, AOFAS<sub>1</sub>) and 6 months after surgery (FADI<sub>2</sub>, AOFAS<sub>2</sub>), and control MR is performed 1 year and more after surgery. Surgery is performed in spinal anesthesia, patient is prone on operative table with ankle over the edge of table and tourniquet on upper leg (11, 20, 32). Two portals (posterolateral and posteromedial) are placed as in routine posterior ankle endoscopy – on medial and lateral side of Achilles tendon (Figure 2). FHLT is located, looped and harvested in zone 2 (Figure 3). Posterior fascia over the FHL muscle belly is cut, allowing FHL to further come close to Achilles tendon. FHLT is pulled out through posteromedial portal, Fiberwire suture is put at the end of FHLT as a Krakow stitch and



Figure 2. Posterior ankle arthroscopy. Standard posterolateral and posteromedial portals are used.

Slika 2. Stražnja artroskopija gležnja. Koriste se standardni posterolateralni i posteromedijalni portali.

tendon is measured (Figure 4). Guidewire with eyelet is driven through the tip of calcaneal tuber in direction for posteromedial proximal to inferolateral distal and tunnel is drilled equal to or 0.5mm larger than tendon diameter in depth 28 mm - 32 mm (Figure 5). Then suture is pulled on lateral side of foot with a help of guidewire Figure 6). The foot is held in equinus position of 20° and Biotenodesis screw or SwivelLock anchor (Arthrex, 4,75mm) is put beside the transferred tendon from posteromedial portal (figure 7A). At the exit point of sutures the skin is opened and sutures secured with endobutton (Arthrex)(figure 7B). Walker orthosis with foot in 20° is kept for 2 weeks. Additional

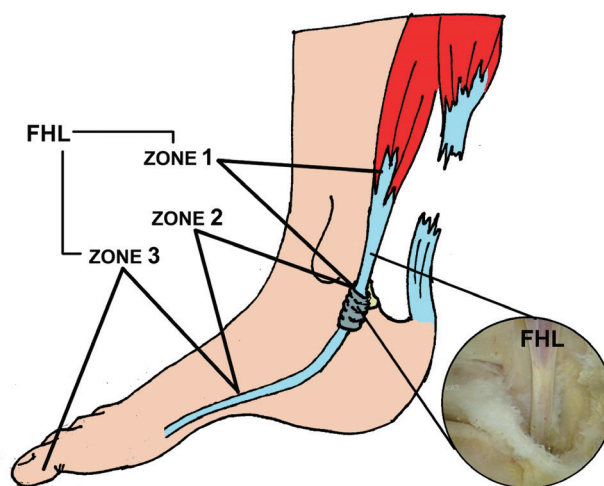


Figure 3. Flexor hallucis longus tendon (FHLT). Zone 1 is located from muscle belly to entry point in sulcus FHLT in talus. Zone 2 is defined from entry point in sulcus until Henry knot (area of crossing of FHL and FDL tendons). Zone 3 is distal from Henry knot.

Slika 3. Tetiva Flexor hallucis longus (FHLT). Zona 1 nalazi se od trbuha mišića do ulazne točke u sulcus FHLT u talusu. Zona 2 definirana je od ulazne točke u sulcusu do Henryjevog čvora (područje križanja FHL i FDL tetiva). Zona 3 je distalno od Henryjevog čvora.

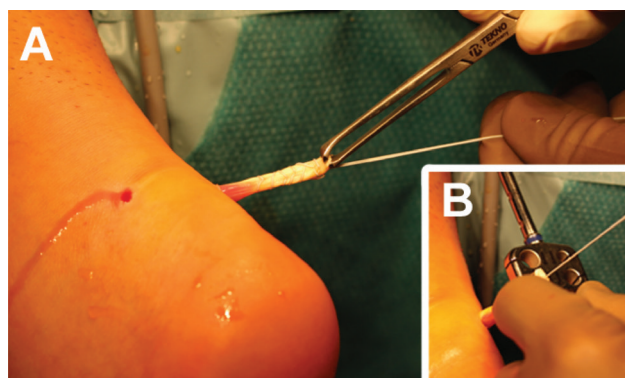


Figure 4. FHLT is pulled on medial portal, sutured through with Krakow stitch and diameter of the tendon is measured for choosing appropriate drill.

Slika 4. FHLT se povlači na medijalnom portalu, prošiva Krakow šavom i mjeri se promjer tetive za odabir odgovarajućeg svrdla.

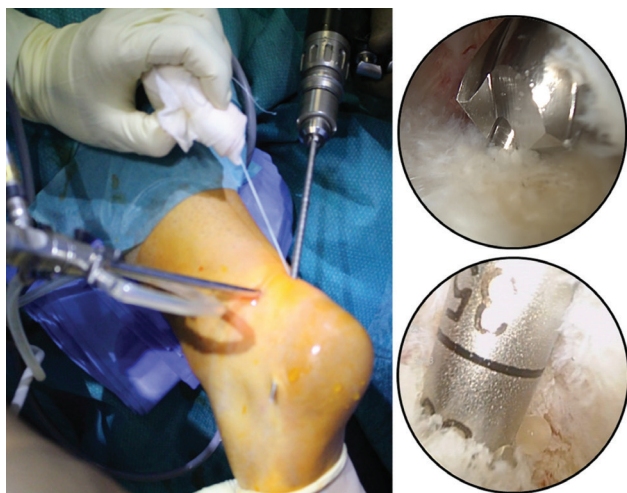


Figure 5. Drilling over a guidewire driven through calcaneal tuber from posteromedial proximal to anterolateral distal.

Slika 5. Bušenje preko žice vodilice provučene kroz kalkanealni tuber u smjeru od posteromedijalno proksimalno prema anterolateralno distalno.

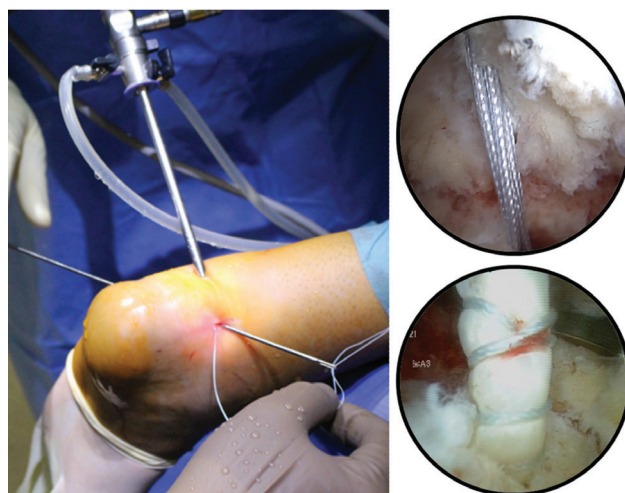


Figure 6. Via guidewire the FHLT sutures are pulled from posteromedial proximal to anterolateral distal. The FHLT is thus driven in the calcaneal tunnel.

Slika 6. Preko žice vodilice konci s vrška FHLT povlače se u smjeru od posteromedijalno proksimalno prema anterolateralno distalno. FHLT se tako uvlači u kalkanealni tunel.

2 weeks the foot is held in 10 degrees of plantarflexion and after that in neutral position. The walker orthosis is removed 6 weeks after surgery and full weight bearing is allowed. Physiotherapy included mobilisation of ankle, strenghtening of calf muscles, eccentric exercises. Control MRI of Achilles tendon was performed after 1 year post surgery.

## RESULTS

The mean preoperative FADI<sub>1</sub> was 49 (34-62, median 51), and the postoperative FADI<sub>2</sub> was 81 (43-100, median 100). The preoperative AOFAS<sub>1</sub> was 60 (51-79, median 68), and the postoperative AOFAS<sub>2</sub> was 92 (76-100, median 100).

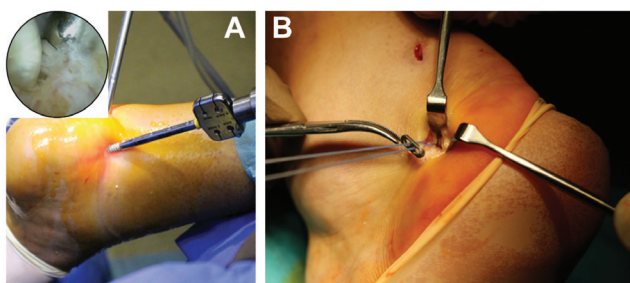


Figure 7. A – inserting a Biotenodesis screw as intereference screw. B – securing the FHLT on lateral side of calcaneus with Endobutton.

Slika 7. A – uvrtnanje Biotenodesis vijka kao intereferentnog vijka. B – pričvršćivanje FHLT-a na bočnoj strani petne kosti pomoću Endobutton pločice.

Complications were; interference screw fracture in one patient and Endobutton plate irritation in one patient. There were no reruptures, infections, neurological lesions or other complications. In all patients there was an improvement in the functional clinical status and they all returned to their preferred previous recreational sport activities. In all patients we found hypertrophy of FHL and homogeneous MRI image of Achilles tendon structure one year after surgery (Figure 8).

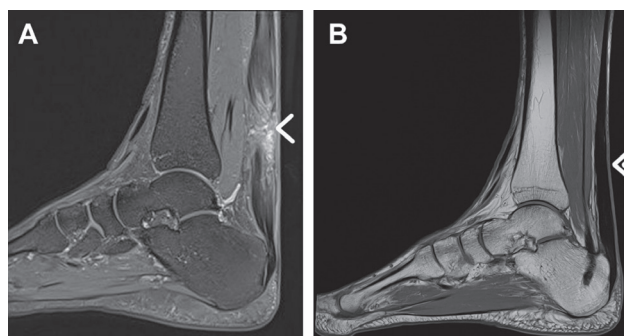


Figure 8. A - MRI of the patient with chronic degenerative Achilles tendon rupture (arrow <). B – MRI of the same patient 5 years after FHLT transfer. There is obvious full restoration of Achilles tendon structure (double arrow <<) and one can notice hypertrophy of FHLT.

Slika 8. A – MR gležnja pacijenta s kroničnom degenerativnom rupturom Ahilove tetive (strelica <). B – MR istog gležnja, istog pacijenta 5 godina nakon premještanja FHLT-a. Očita je potpuna obnova strukture Ahilove tetive (dvostruka strelica <<) i može se uočiti hipertrofija FHLT-a.

## DISCUSSION

One of the most common risk factors for Achilles tendon rupture is tendon degeneration and a change in the structure of its tissue, which can no longer withstand the expected and more intense efforts (14). Primary reconstruction and suturing of such tissue, which is additionally loaded with suture material, weakened by debridement or supplemented with augmentation, cannot guarantee full and quick recovery with minimal tissue damage. None of the known open methods enhance the regeneration support of the damaged tendon. Although the FHL muscle is weaker than the peroneus brevis, the direction of activity of the FHL and the retention of eversion of the foot make the FHLT ideal for replacing or supplementing the function of the damaged Achilles tendon (33, 34). Based on biomechanical studies of the functionality of the muscles of the posterior aspect of the lower leg and on the basis of open procedures in which the FHLT is used for augmentation, with the development of endoscopic techniques around the ankle, techniques for endoscopic transfer of the FHL tendon are gradually being developed, primarily for chronic AT ruptures, then for degenerative non-insertional Achilles tendinopathies, and in the last few years for acute Achilles tendon ruptures in athletes (12, 13, 15). Utilization of the FHLT reduces the strength of plantar flexion of the thumb, but not enough to be clinically significant even in athletes involved in high-intensity jumping sports (26, 30). FHLT transfer helps to restore Achilles tendon integrity by allowing unloading and regeneration of tendon. Lui describes endoscopic FHLT transfer for treatment chronic noninsertional Achilles tendinopathy (22). This method significantly enlarges strength of damaged and degenerated Achilles tendon introducing indication that FHLT transfer is indicated with >50% of tendon is injured or debrided (27). Regarding

the method of fixation of the transferred FHLT – fixation with an interference screw is just as strong as fixation with a transosseous suture (7). Combined fixation with an interference screw and Endobutton plate is stronger than fixation with a interference screw alone and is recommended for osteopenic bone (25). It is advantageous to place a unicortical tunnel and maintain the integrity of the distal calcaneal cortex (17, 20). The direction of the bone tunnel and screw placement may vary (10, 11, 16, 18, 20, 21, 31). However, due to less irritation, we recommend a direction from medial, posterior and proximal to lateral, anterior and distal, with an exit point at the lateral part of the calcaneus, i.e. at the junction with the skin of the sole. Dorsal and discrete medial placement of the entrance opening of the tunnel for transposing the FHLT still provides somewhat stronger activity and effect of the transposed tendon (4, 29). Over time, the transposed FHLT hypertrophies, supporting the function of the damaged Achilles tendon, which we have also shown in our patients with a control MRI image (Figure 8B)(19). Patients are very satisfied with the functional outcome of the procedure. In our study, FADI increased from 49 to 81, AOFAS from 60 to 92. Similar results have been reported by other authors. Abubeih et al. reported an increase in AOFAS score from 57 to 95 (1).

## CONCLUSION

Endoscopic FHLT transfer on calcaneal tuberosity is reliable, minimally invasive procedure for restauration of injured Achilles tendon function in active patients. This method provides fast recovery and full return to previous sport activities. In this study we did not test difference in intensity and level of preoperative and postoperative sport activity.

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