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Original Article

A long harvest of the flexor hallucis longus provides grafts that are more suitable for large Achilles defects

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Abstract

Objective: To compare the short (zone 1) and intermediate (zone 2) harvest zones of the flexor hallucis longus (FHL) tendon to a long harvest site at the interphalangeal joint of the hallux (zone 3).

Methods: Fourteen fresh-frozen cadaveric lower limbs were used to measure the FHL tendon length across zones 1, 2, and 3, tendon thickness, calcaneal tunnel length, percentage of tendon inside the tunnel, and the relation between the base of the first metatarsal and the medial plantar nerve.

Results: In the short harvest, the mean FHL tendon length was 22.9 ± 4.5 mm with the ankle in neutral position, and 33.2 ± 4.1 mm with the ankle in 15º of plantarflexion. Mean FHL thickness was 6.2 ± 0.8 mm. The mean calcaneal tunnel length was 44.1 ± 4.2 mm, and the mean length of the tendon traversing the bone tunnel was 21 ± 3.2 mm, while covering a mean of 48.5% of tunnel length. The FHL length at the intermediate harvest was 48.9 ± 5.7 mm with a mean distance of 24 ± 4.8 mm between the base of the first metatarsal and the medial plantar nerve. The FHL length was the longest during the long harvest, at 128.6 ± 7.1 mm.

Conclusion: The short harvest provided FHL grafts that covered only 48.5% of the calcaneal tunnel. The long harvest provides longer FHL grafts suitable for large Achilles defects, in which augmentation with the remaining FHL tendon may be needed.

Level of evidence V.

Keywords: Tendons; Achilles tendon; Hallux; Ankle; Cadaver.

Introduction

While the Achilles tendon represents the most robust tendinous structure in the human anatomy, it remains a frequent site of complete rupture[1,2] and the incidence has been increasing in the last few decades[3-5]. Although the increasing trend is to treat Achilles tendon tears non-surgically[4], surgical treatment may be indicated[6], especially in chronic cases[7]. Surgical strategies for Achilles reconstruction vary, ranging from direct apposition to complex augmentation involving synthetic scaffolds or autologous transfers, depending on the chronicity and gap size of the lesion[1,7].

The strip of the tensor fasciae latae or tendon allograft is commonly used for Achilles tendon reconstruction[7]. However, these tissues are avascular, more prone to infection, lack an intact and functional muscle belly, and do not provide the natural stability of an autograft[8]. Functional muscle-tendon free flaps involve microsurgical skills and may result in prolonged rehabilitation[8]. Instead, tendon transfers are ideal to augment or fully substitute an incompetent Achilles tendon when the defect is between 3 and 6 cm[7]. Tendon transfer to reconstruct the Achilles tendon is usually accomplished using the peroneus brevis tendon or the flexor hallucis longus (FHL) tendon, with comparable long-term functional results[7,9].

Study performed at the Department of Anatomy and Human Embryology, Faculty of Medicine, University of Barcelona, Spain.

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Anatomically situated as the most posterior constituent of the deep posterior compartment, the FHL lies near the typical zone of Achilles tendon rupture. In terms of biomechanical output, it serves as the primary accessory plantar flexor, surpassed in torque only by the triceps surae, yet exceeding the contractile force of both the peroneus brevis and the flexor digitorum longus. The FHL muscle acts synergistically with the triceps surae, with a mechanical axis that resembles the Achilles tendon[10]. Following transposition, the FHL demonstrates significant physiological plasticity, with documented compensatory hypertrophy reaching up to 52%[11], and the FHL muscle belly provides a vital vascularized pedicle, thereby introducing an auxiliary blood supply to the notoriously hypovascular 'watershed area' of the Achilles tendon[1]. Despite the predictable diminution of hallux flexion power following FHL transposition, subjective and objective functional outcomes remain high, as most patients successfully adapt to this compensatory change[12-14].

Conventional FHL harvesting occurs either at the level of the subtalar joint (zone 1), immediately distal to the posterior sulcus, or at the intersection of the flexor digitorum longus, known as the knot of Henry (zone 2). However, during the reconstruction of large Achilles defects, these harvest locations may result in an inadequate tendon length[8]. The long FHL harvesting can be done at the level of the base of the hallux (zone 3) to obtain a substantially longer tendon graft[8]. The long FHL harvesting technique has been previously described[8], but it remains important to understand if this harvesting technique is consistent and reliable for harvesting longer FHL grafts.

The objective of this cadaveric study is to compare the FHL tendon length as harvested in zones 1, 2, and 3, while also measuring other important tendon-specific metrics of the long FHL harvest. It was hypothesized that harvesting the FHL tendon at zone 1 would not always provide an adequate graft length for large Achilles, resulting in insufficient graft-to-tunnel length.

Methods

The study was performed in the Department of Anatomy and Human Embryology at the University of Barcelona. In accordance with the Spanish legal and ethical regulations regarding anatomical donation, 14 fresh-frozen cadaveric specimens (Table 1) were obtained through an institutional body donation program for analysis. In the absence of a preliminary sample size calculation, the study used the total cohort of available ankle specimens to maximize the statistical power within the constraints of the donor program. All cadaveric specimens were free of any signs of previous surgery or trauma, congenital or developmental deformities, or inflammatory ankle arthritis. No anatomic variants of the FHL tendon were observed.

Three incisions were planned for the long FHL harvest: the primary posterior-medial, the midfoot, and the hallux digital sulcus incision (Figure 1). For practical purposes, the skin and subcutaneous tissue were removed from the plantar and medial region of the foot.

Table 1. Demographic properties of study specimens

Specimen (n = 14)	
Age at donation	
Mean ± SD	84.5 ± 13.5
Median (Min-Max)	87.5 (55-95)
Side	
Right	7 (50%)
Left	7 (50%)
Sex	
Male	3 (21.4%)
Female	11 (78.6%)

SD: Standard deviation.

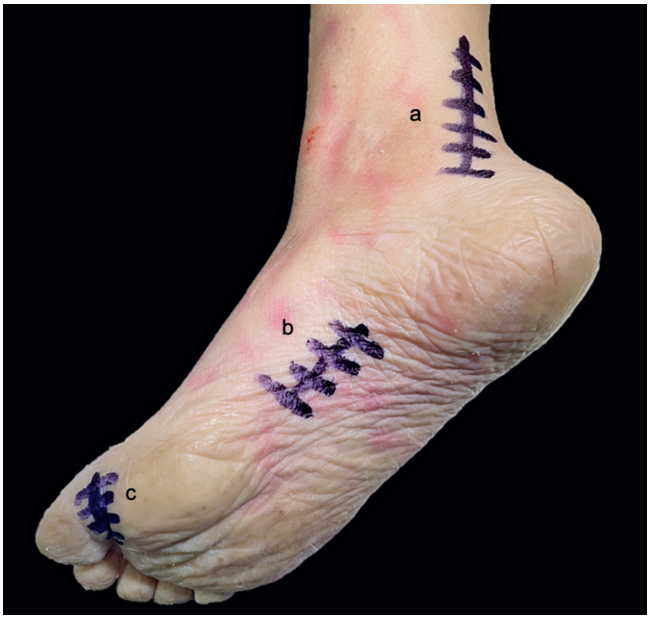

Figure 1. Three incisions are planned for the long flexor hallucis longus harvest: the primary posteromedial surgical incision (a), the midfoot (b), and the hallux digital sulcus (c).

The harvesting procedure started with the dissection and identification of the medial plantar nerve over the fascia of the flexor hallucis brevis (FHB). For intermediate harvest, the base of the first metatarsal was used as a useful anatomical reference, for which it was measured the distance between the middle area of the base of the first metatarsal and the medial plantar nerve, since the plantar nerve is at the highest risk of iatrogenic injury in this plantar approach (Figure 2). Following these initial preparations, the dissection and measurement of the tendon length at zones 1, 2, and 3 proceeded.

For zone 1, the dissection followed a posterior-medial approach in the ankle. The aponeurotic sheath overlying the posterior compartment was incised in a cranio-caudal

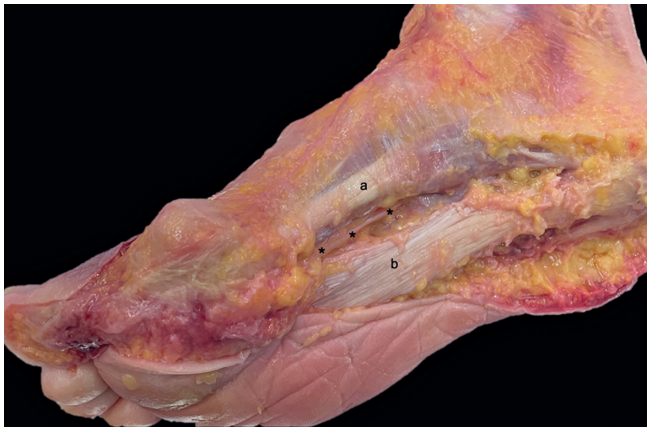

Figure 2. In the medial plantar incision, we identify the abductor hallucis (a), the plantar fascia (b), and the medial plantar nerve over the flexor hallucis brevis fascia (*).

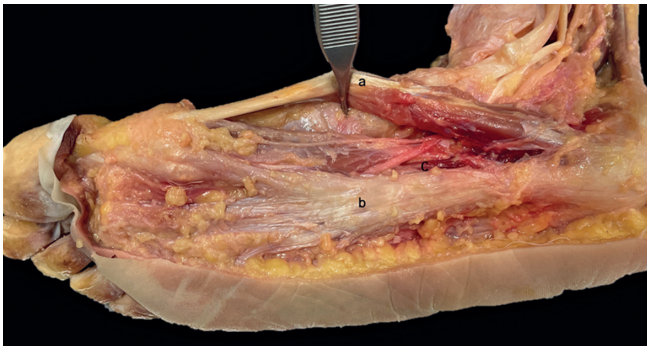

Figure 3. In the medial plantar incision, the abductor hallucis muscle (a) and the plantar fascia (b) are retracted away from one another, and by flexing the great toe, the flexor hallucis longus tendon (c) is identified just deep to the abductor hallucis muscle between the two heads of the flexor hallucis brevis over its aponeurosis.

direction to enable visualization of the superficial and deep muscle groups, followed by blunt dissection to isolate the FHL muscle belly with its tendon. The neurovascular bundle of the posterior tibia was identified within its characteristic adipose investment; its proximity to the FHL medial border required diligent protection during surgical exposure. Following the FHL mobilization from the posterior talar sulcus, the tendon length was quantified. These measurements were obtained under two specific conditions: with the ankle at 0° (neutral) and at a 15° plantarflexion. The FHL was then completely released, and the thickness was measured.

For zone 2, the abductor hallucis muscle (AHM) and plantar fascia were retracted away from each other, and by flexing the great toe. The FHL tendon was identified just deep to the AHM, between the two heads of the FHB over its aponeurosis (Figure 3). The AHM was then reflected plantarwardly with the FHB to expose the flexor digitorum longus (FDL) and FHL in the midfoot, at the master knot of Henry (Figure 4).

FHL harvesting in zone 3 is easier because it is superficial at the level of the distal hallux phalanx insertion. The FHL tendon was harvested via a posteromedial incision; maximal graft length was achieved by performing the transection at the posterior sustentaculum with the ankle and first digit in 15° of plantarflexion. To mitigate the risk of iatrogenic injury to the adjacent neurovascular bundle, the transection was executed in a medial-to-lateral direction using sharp dissection. Controlled tension was applied during retrieval to ensure the integrity of the musculotendinous interface.

The FHL autograft transfer was simulated in all cadaveric specimens to measure the graft-to-bone-tunnel length and ratio. The procedure followed the FHL (zone 1) harvesting, and a Krackow whipstitch using 2-0 Ethibond suture was applied. A 7-mm drill hole was then created directly in the midline and anterior to the Achilles tendon insertion on the superior aspect of the calcaneal tuberosity. This drill hole was

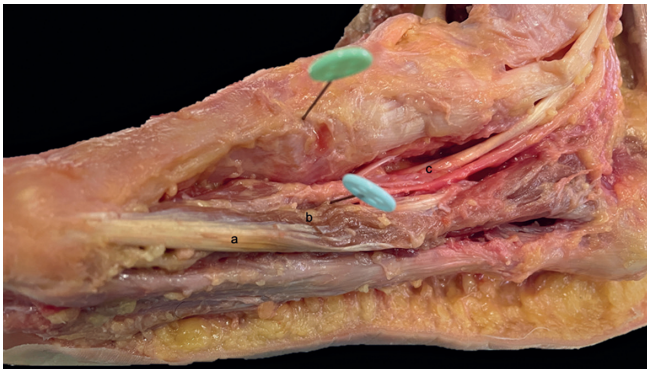

Figure 4. The abductor hallucis muscle (a) was then reflected plantarwardly with the flexor hallucis brevis (b) to expose the flexor digitorum longus and flexor hallucis longus decussation in the midfoot at the master knot of Henry (c).

created with a slightly lateral trajectory from the entry point, similar to the technique previously described by Hong et al.[15] and Ferrero-Recaséns et al.[16]. Following measurement of the bone tunnel dimensions, the FHL tendon stump was shuttled into the calcaneus via a guidewire. The fixation sutures were exteriorized through a lateral plantar incision. To determine the extent of tendon-to-bone contact, the FHL length residing within the tunnel was recorded at 15° of plantarflexion, measured from the tunnel entry point to the distal end of the graft (Figure 5). The tendon graft length with ankle plantar flexion was compared to the tunnel length to calculate the graft-to-tunnel ratio (%).

All measurements were made with a digital caliper and recorded in millimeters (mm). Measurements were tabulated for each specimen and summarized using descriptive analysis to calculate means and standard deviations from all 14 specimens.

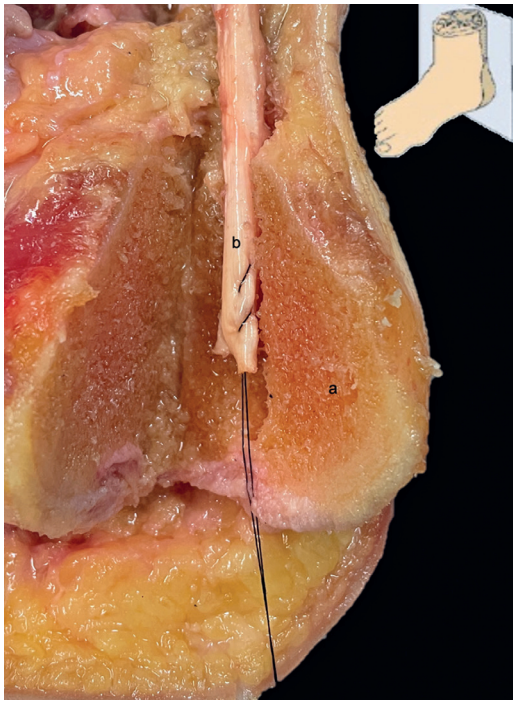

Figure 5. Coronal view of the calcaneus (a) with the flexor hallucis longus tendon (b) transected inside. The short harvest (zone 1) results in approximately half of the tendon being inside the calcaneal tunnel.

Results

In the short harvest, the mean FHL tendon length was shorter with the ankle in neutral position (22.9 ± 4.5 mm, range 15 to 30) than with the ankle in 15º of plantarflexion (33.2 ± 4.1 mm, range 26 to 38). The FHL thickness was 6.2 ± 0.8 mm (range 5 to 8). The calcaneal osseous tunnel exhibited a mean longitudinal dimension of 44.1 mm ± 4.2 mm (range 38 to 52), and the mean intraosseous FHL tendon length situated within the calcaneal tunnel was 21.0 mm ± 3.2 mm (range 15 to 26), while covering 48.5% of the tunnel length (Table 2).

In the intermediate harvest, the mean FHL tendon length was 48.9 ± 5.7 mm (range 39 to 56), and in the long harvest, the mean length was the longest with 128.6 ± 7.1 mm (range 120 to 141).

The mean distance between the base of the first metatarsal and the medial plantar nerve was 24 ± 4.8 mm (range 19 to 33).

Discussion

This cadaveric study provides anatomical data about the short, intermediate, and long harvest of the FHL tendon. It is difficult to acquire an adequate FHL tendon length for the reconstruction of large Achilles tendon defects. Hansen[17] was among the first to describe the method for harvesting the FHL tendon using a single posteromedial incision (zone 1). While the short-harvest technique is often reported to provide over 70% of the FHL tendon graft in the osseous

Table 2. Tunnel and flexor hallucis longus size metrics for short, intermediate, and long harvest

Specimen No.	Calcaneal tunnel length (mm)	Short harvest (Zone 1)					Intermediate harvest (Zone 2)	Long harvest (Zone 3)	Distance between the base of the 1st metatarsal to the medial plantar nerve (mm)
		Tendon length (mm)		Tendon length (mm) (plantar flexion) inside the tunnel	Tendon graft (plantar flexion) to tunnel length ratio (%)	Thickness (mm)	Tendon length (mm)		
		In neutral position	In plantar flexion						
1	38	26	37	15	39	6	56	128	31
2	42	18	26	18	43	6	51	129	33
3	41	15	28	23	56	6	48	128	19
4	47	30	34	19	45	8	56	140	21
5	45	23	38	21	47	7	53	120	22
6	39	15	28	18	46	6	46	120	22
7	39	26	38	24	62	6	39	126	24
8	42	21	31	18	43	7	54	125	19
9	45	24	33	23	51	6	39	120	30
10	45	23	33	22	49	6	49	124	29
11	45	23	38	21	47	6	53	130	20
12	51	23	30	20	39	7	48	130	24
13	46	28	36	26	62	5	51	141	20
14	52	26	35	26	50	5	42	139	22
Mean	44.1	22.9	33.2	21	48.5	6.2	48.9	128.6	24
SD	4.2	4.5	4.1	3.2	7.3	0.8	5.7	7.1	4.8

SD: Standard deviation.

tunnel at all times[15], the present cadaveric study found that the mean coverage ratio was 48.5%, with none of the specimens surpassing the 70% cut-off. One possible reason for this finding may be related to the fact that in the present study, the short FHL graft (22.9 ± 4.5 mm) was not measured while performing maximum plantar flexion or by excessive traction of the FHL at the time of fixation in the tunnel, due to the risk of possible tear of the muscle belly. Another potential reason may be that Hong et al.[15] compared the total FHL length (short harvest) against the tunnel length, whereas in the present study, only the FHL length inside the tunnel was considered. When measured as in the present study, it provides a more accurate estimate of the actual FHL length within the bone tunnel.

To optimize the longitudinal dimensions of the FHL graft, the tendon can be divided at its midfoot intersection with the flexor digitorum longus (the knot of Henry) using a double-incision technique[10]. However, even an intermediate harvest technique (48.9 ± 5.7 mm) can result in a suboptimal tendon length for large Achilles defects and is insufficient for concomitant augmentation transfer of the remaining FHL tendon. Distal retrieval of the FHL tendon at the hallux base[8] yields a significantly longer graft (128.6 ± 7.1 mm), providing sufficient longitudinal dimension for virtually all Achilles tendon reconstruction requirements. Due to the frequent presence of intertendinous connections between the FHL and the FDL[18], it is recommended to make three incisions (Figure 1) when making a long harvest (zone 3) to release the FHL in the midfoot.

Moreover, performing a double incision instead of the single incision technique when harvesting the FHL tendon may provide a longer FHL graft[19].

The mean FHL thickness and the calcaneal tunnel length were provided to guide the orthopedic surgeon while implementing the short FHL harvesting technique.

When performing the calcaneal tunnel length, a mean length of 44.1 ± 4.2 mm is expected, and therefore, adjust the FHL graft to fit at least 15 mm inside the tunnel. For example, in anterior cruciate ligament reconstruction, histological maturation and the subsequent biomechanical integrity of the tendon-bone interface are significantly compromised at the six-week postoperative mark if the intraosseous graft length is less than 15 mm[20]. Maximizing FHL tendon graft length within the bone tunnel and minimizing tendon-tunnel diameter mismatch will maximize the strength of a tendon-bone tunnel complex[21]. The mean thickness of the FHL will help the surgeon determine the minimum tunnel diameter and when to choose the most suitable tenodesis screw, with thicker FHL grafts allowing larger screws (rather than suturing the folded FHL to itself). Fixation utilizing bioabsorbable interference screws demonstrated superior biomechanical resistance to pull-out forces when compared to the conventional 'loop-and-suture' technique, in which the FHL graft is secured to itself using #1 Ticron suture after transosseous passage[22].

The FHL harvest carries inherent risks, including iatrogenic damage to the medial plantar nerve when harvesting in zone 2. A previous cadaveric study[23] performed FHL harvesting in zone 2 and measured the distance from the medial plantar nerve to the FHL's proximal fibrous zone (2A) and distal fascial zone (2B). The proximity of the medial plantar nerve to the FHL's tendon sheath creates a considerable risk of iatrogenic nerve injury when surgical procedures are performed in zone 2B. The distance between the base of the first metatarsal and the medial plantar nerve can serve as an important landmark in the plantar approach to identify the potential location of the medial plantar nerve and thus mitigate the risk of iatrogenic injury.

Each harvesting zone yields specific advantages and disadvantages. Harvesting in zone 1 results in less morbidity due to less surgical trauma and decreased harvesting time, but has considerable disadvantages, such as providing a shorter graft length, creating a higher risk of neurovascular injury if distal transection is performed blindly, and the inability to perform a tenodesis of the FHL remnant to the FDL. The benefits of harvesting in zone 2 are the ability to perform a tenodesis from the distal FHL remnant to the FDL and a longer graft length. However, harvesting in zone 2 will create further morbidity from a second medial incision along the foot with the possibility of neurovascular injury while dissecting near the neurovascular bundle at the knot of Henry. In turn, Zone 3 provides a much longer graft length and the possibility of augmentation, but requires three surgical incisions (even more surgical-related morbidity) and a longer surgery time. Moreover, some studies argue that great toe flexion stability for ground grip during stance gait has been a concern with the intermediate and long FHL harvest[8]. Despite the sacrifice of the primary hallux flexor, numerous investigations have demonstrated that the procedure typically results in preserved foot function with no significant deleterious effects on gait or daily activities[13,24-27].

The long FHL harvest technique provides longer grafts, and its potential remains unexplored. The extended harvest of the FHL provides a versatile source of autogenous tissue, suitable for the reconstruction of various tendinopathies, including those of the peroneal or tibialis anterior tendons[8].

Harvesting in zone 3 provides longer FHL grafts that are more appropriate for large Achilles defects, where an augmentation with the remaining FHL tendon may be needed. The distance between the base of the first metatarsal and the medial plantar nerve can serve as an important landmark in the plantar approach to identify the potential location of the medial plantar nerve and thus mitigate the risk of iatrogenic injury.

The present study has several limitations. The number of the cadaveric specimens was limited to those available for examination. Measurements were only accomplished by one assessor at one time, precluding the computation of intra- and inter-rater reliability; notwithstanding, all measures were made with utmost caution to avoid any inconsistencies.

The relative stiffness of frozen-thawed tendons may affect graft elongation and retrieval. Additionally, the restricted articular mobility characteristic of cadaveric models may not precisely simulate the dynamic plantarflexion observed in clinical practice, potentially affecting the reported harvesting dimensions. Lastly, variation in the distal transection site may have influenced the final graft length obtained.

Conclusion

The short harvest provided FHL grafts that covered a mean of only 48.5% of the calcaneal tunnel. The long harvest provides longer FHL grafts, which are more suitable for large Achilles defects, where an augmentation with the remaining FHL tendon may be needed. The distance between the base of the first metatarsal and the medial plantar nerve can guide orthopedic surgeons to avoid plantar nerve iatrogenic injury during intermediate FHL harvesting.

Authors' contributions: Each author contributed individually and significantly to the development of this article: DABS *(https://orcid.org/0000-0001-7005-896X) Conceived and planned the activities that led to the study, interpreted the results of the study, participated in the review process, performed the surgeries, data collection, statistical analysis, bibliographic review and formatting of the article; MFZL *(https://orcid.org/0000-0002-9434-9961) Interpreted the results of the study, participated in the review process, performed the surgeries, data collection, statistical analysis; RA *(https://orcid.org/0000-0002-7636-7816) Data collection, statistical analysis, bibliographic review and formatting of the article; TDS *(https://orcid.org/0000-0001-9576-8351) Conceived and planned the activities that led to the study, interpreted the results of the study, participated in the review process and formatting of the article; XMO *(https://orcid.org/0000-0003-2231-0678) Conceived and planned the activities that led to the study, interpreted the results of the study, participated in the review process and formatting of the article. All authors read and approved the final manuscript. *ORCID (Open Researcher and Contributor ID).

References

1. Koh D, Lim J, Chen JY, Singh IR, Koo K. Flexor hallucis longus transfer versus turndown flaps augmented with flexor hallucis longus transfer in the repair of chronic Achilles tendon rupture. Foot and Ankle Surgery. 2019;25(2):221-5.
2. Lyons JG, Berkay FB, Minhas A. Epidemiology of Sports-Related Tendon Ruptures Presenting to Emergency Departments in the United States. Am J Sports Med. 2024;52(13):3396-403.
3. Briggs-Price S, Mangwani J, Houchen-Wolloff L, Modha G, Fitzpatrick E, Faizi M, et al. Incidence, demographics, characteristics and management of acute Achilles tendon rupture: An epidemiological study. PLoS One. 2024;19(6):e0304197.
4. Hallinen M, Sallinen H, Keskinen H, Matilainen M, Ekman E. Regional variations in incidence and treatment trends of Achilles tendon ruptures in Finland: a nationwide study. Acta Orthop. 2024;95:401-6.
5. Lemme NJ, Li NY, DeFroda SF, Kleiner J, Owens BD. Epidemiology of Achilles Tendon Ruptures in the United States: Athletic and Nonathletic Injuries From 2012 to 2016. Orthop J Sports Med. 2018;6(11):2325967118808238.
6. Seow D, Islam W, Randall GW, Azam MT, Duenes ML, Hui J, et al. Lower re-rupture rates but higher complication rates following surgical versus conservative treatment of acute achilles tendon ruptures: a systematic review of overlapping meta-analyses. Knee Surg Sports Traumatol Arthrosc. 2023;31(8):3528-40.
7. Feng SM, Maffulli N, Oliva F, Saxena A, Hao YF, Hua YH, et al. Surgical management of chronic Achilles tendon rupture: evidence-based guidelines. J Orthop Surg Res. 2024;19(1):132.
8. Bibbo C. Long harvest of the flexor hallucis longus tendon in reconstructive foot & ankle surgery: A technique guide. Foot Ankle Surg. 2022;2(2):100206.
9. Maffulli N, Oliva F, Maffulli GD, Buono AD, Gougoulias N. Surgical management of chronic Achilles tendon ruptures using less invasive techniques. Foot Ankle Surg. 2018;24(2):164-70.
10. Wapner KL, Pavlock GS, Hecht PJ, Naselli F, Walther R. Repair of Chronic Achilles Tendon Rupture with Flexor Hallucis Longus Tendon Transfer. Foot Ankle. 1993;14(8):443-9.
11. Oksanen MM, Haapasalo HH, Elo PP, Laine HJ. Hypertrophy of the flexor hallucis longus muscle after tendon transfer in patients with chronic Achilles tendon rupture. Foot Ankle Surg 2014;20(4):253-7.
12. Bussewitz BW. Repair of Neglected Achilles Rupture. Clin Podiatr Med Surg. 2017;34(2):263-74.
13. Lever CJ, Bosman HA, Robinson AHN. The functional and dynamometer-tested results of transtendinous flexor hallucis longus transfer for neglected ruptures of the Achilles tendon at six years' follow-up. Bone Joint J. 2018;100-B(5):584-9.
14. Park YS, Sung KS. Surgical Reconstruction of Chronic Achilles Tendon Ruptures Using Various Methods. Orthopedics. 2012;35(2):e213-8.
15. Hong CC, Lee WT, Murphy DP, Tan KJ. Anatomic Basis for Minimally Invasive Flexor Hallucis Longus Transfer in Chronic Achilles Tendon Rupture. J Foot Ankle Surg. 2018;57(5):938-41.
16. Ferrero-Recaséns J, Mellado Romero MÁ, Vacas Sánchez E, Sánchez Morata EJ, Vilá Y Rico J. Transferencia endoscópica del flexor hallucis longus en el tratamiento de las roturas inveteradas del tendón calcáneo. RPT. 2019;33(1):23-32.
17. Hansen ST. Trauma to the heel cord. Disorders of the Foot and Ankle. 2ed. Vol. 3. Philadelphia: WB Saunders; 1991.
18. Mao H, Shi Z, Wapner KL, Dong W, Yin W, Xu D. Anatomical study for flexor hallucis longus tendon transfer in treatment of Achilles tendinopathy. Surg Radiol Anat. 2015;37(6):639-47.

19. Tashjian RZ, Hur J, Sullivan RJ, Campbell JT, DiGiovanni CW. Flexor Hallucis Longus Transfer for Repair of Chronic Achilles Tendinopathy. Foot Ankle Int. 2003;24(9):673-6.
20. Qi L, Chang C, Jian L, Xin T, Gang Z. Effect of Varying the Length of Soft-Tissue Grafts in the Tibial Tunnel in a Canine Anterior Cruciate Ligament Reconstruction Model. Arthroscopy. 2011;27(6):825-33.
21. Greis PE, Burks RT, Bachus K, Luker MG. The Influence of Tendon Length and Fit on the Strength of a Tendon-Bone Tunnel Complex: A Biomechanical and Histologic Study in the Dog. Am J Sports Med. 2001;29(4):493-7.
22. Cohn JM, Sabonghy EP, Godlewski CA, Clanton TO, McGarvey WC. Tendon Fixation in Flexor Hallucis Longus Transfer: A Biomechanical Study Comparing a Traditional Technique Versus Biobasorbable Interference Screw Fixation. Tech Foot Ankle Surg. 2005;4(4):214-21.
23. Lui TH, Chan KB, Chan LK. Cadaveric Study of Zone 2 Flexor Hallucis Longus Tendon Sheath. Arthroscopy. 2010;26(6):808-12.
24. Coull R, Flavin R, Stephens MM. Flexor Hallucis Longus Tendon Transfer: Evaluation of Postoperative Morbidity. Foot Ankle Int. 2003;24(12):931-4.
25. Hahn F, Meyer P, Maiwald C, Zanetti M, Vienne P. Treatment of Chronic Achilles Tendinopathy and Ruptures with Flexor Hallucis Tendon Transfer: Clinical Outcome and MRI Findings. Foot Ankle Int. 2008;29(8):794-802.
26. Richardson DR, Willers J, Cohen BE, Davis WH, Jones CP, Anderson RB. Evaluation of the Hallux Morbidity of Single-Incision Flexor Hallucis Longus Tendon Transfer. Foot Ankle Int. 2009;30(7):627-30.
27. Wilcox DK, Bohay DR, Anderson JG. Treatment of chronic achilles tendon disorders with flexor hallucis longus tendon transfer/ augmentation. Foot Ankle Int. 2000;21(12):1004-10.