



Endoscopic Release of the Flexor Hallucis Longus Tendon at Posterior Ankle for Management of Checkrein Deformity of the Great Toe, Second Toe, and Third Toe

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Abstract: Checkrein deformity is rare and involves entrapment or fixed tethering of the flexor hallucis longus (FHL) in the posterior foot, just proximal to the flexor retinaculum of the ankle, and causes the “constant length phenomenon” of FHL. The clinical presentation is a dynamic flexion deformity of the great toe characterized by flexion contracture of the interphalangeal joint with mild extension contracture of the metatarsophalangeal joint, causing difficulty in walking since in the stance phase of gait, the hallux is forced into plantar flexion and impinges onto the ground. Because the FHL tendon has some interconnection to the tendons of the flexor digitorum longus at the master knot of Henry, deformities of the second and third toes are sometimes seen. There is no standard surgical treatment for checkrein deformity. Surgical release of the FHL muscle or release/lengthening of the FHL tendon has been proposed. The purpose of this Technical Note is to report the endoscopic release of the FHL tendon at the posterior ankle for management of checkrein deformity of the great toe, second toe, and third toe.

Checkrein deformity is rare and involves entrapment or fixed tethering of the flexor hallucis longus (FHL) in the posterior foot, just proximal to the flexor retinaculum of the ankle, and causes the “constant length phenomenon” of FHL.^{1,2} This deformity can be due to FHL tendon tethering, muscle contracture, or both.¹ The clinical presentation is a dynamic flexion deformity of the great toe characterized by flexion contracture of the interphalangeal joint with mild extension contracture of the metatarsophalangeal joint, causing difficulty in walking since in the stance

phase of gait, the hallux is forced into plantar flexion and impinges onto the ground (Fig 1).^{1,3}

Acute checkrein deformity is very rare and can be due to entrapment of the FHL tendon after closed reduction of the dislocated subtalar joint or the FHL tendon entrapped between fracture fragments.⁴⁻⁶ More commonly, the deformity develops over time and is caused by contractures triggered by ischemic changes in muscles and tendons, adhesions to surrounding tissues, tendon insertion into the fracture site, and callus formation after a fracture.^{2,7} Because the FHL tendon has some interconnection to the tendons of the flexor digitorum longus (FDL) at the master knot of Henry, deformities of the second and third toes are sometimes seen.¹

There is no standard surgical treatment for checkrein deformity.^{1,8} Surgical release of the FHL muscle or release/lengthening of the FHL tendon has been proposed.^{3,8-13} Z-plasty of the FHL at the midfoot level has the advantage to operate in an operative field free of scar tissue with a lower risk of recurrence.^{1,2} Moreover, this approach allows the untwining of the connections between the FHL and the FDL if needed.³ On the other hand, Z-plasty can be performed at the posteromedial ankle.³ This medial retromalleolar approach allows tendon/muscle adhesiolysis together

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Fig 1. Endoscopic release of the flexor hallucis longus tendon at the posterior ankle for management of checkrein deformity of the great toe, second toe, and third toe of the right foot. The patient is in the prone position. In the stance phase of gait, the hallux is forced into plantar flexion and impinges onto the ground.

with FHL lengthening.⁸ It should be noted that adhesiolysis alone can improve movement, but tendon lengthening or release should be performed to correct the deformity.^{8,13}

Classically, surgical correction of checkrein deformity is performed with an open approach, requiring a large incision with extensive soft tissue dissection, especially around the neurovascular structures.¹⁴ The purpose of this Technical Note is to describe the details of endoscopic release of the FHL tendon at the posterior ankle. It is indicated for management of checkrein deformity of the great toe, second toe, and third toe. It is contraindicated if the patient participates in sports using the FHL (e.g., ballet dance). It is also contraindicated if the deformity is due to FDL dysfunction or the fibrous adhesion involves the FHL tendon at the sustentaculum tali or midfoot region (Table 1).

Technique

Preoperative Assessment and Patient Positioning

On examination, the hallux flexion deformity worsens with passive dorsiflexion of the ankle and

Table 1. Indications and Contraindications of Endoscopic Release of the Flexor Hallucis Longus (FHL) Tendon at the Posterior Ankle for Management of Checkrein Deformity of the Great Toe, Second Toe, and Third Toe

Indications	Contraindications
Checkrein deformity of the great toe, second toe, and third toe.	The patient participates in a sport using the FHL (e.g., ballet). The deformity is due to FDL dysfunction. The deformity is due to fibrous adhesion involving the FHL tendon at the sustentaculum tali or midfoot region.

is corrected completely with ankle plantarflexion (Fig 2).^{1,3}

Ultrasound study can be used to determine the location of adhesions to guide the surgical planning.¹ It has the advantage of providing dynamic examination of the FHL tendon and muscle and better assessment of the adhesions or the contracture state of the muscle.¹

The patient is in a prone position with a thigh tourniquet to provide a bloodless operative field. A 4.0-mm 30° arthroscope (Dyonics; Smith and Nephew) is used for this procedure.

Portal Placement

This procedure is performed with the posteromedial and posterolateral portals. The posterolateral portal is located at the lateral side of the Achilles tendon just above the posterior calcaneal tubercle. The posteromedial portal is located at the intersection point between the medial border of the Achilles tendon and the line joining the undersurface of the sustentaculum tali and first metatarsal (Fig 3).^{15,16} Five-millimeter skin incisions are made at the portal sites and the subcutaneous tissue is bluntly dissected by a hemostat and the investing fascia is penetrated by the tip of the hemostat.



Fig 2. Endoscopic release of the flexor hallucis longus tendon at the posterior ankle for management of checkrein deformity of the great toe, second toe, and third toe of the right foot. The patient is in the prone position. On examination, the hallux flexion deformity worsens with passive dorsiflexion of the ankle (A) and is corrected completely with ankle plantarflexion (B).

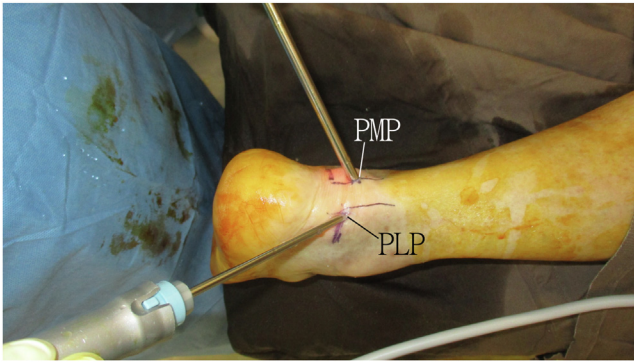


Fig 3. Endoscopic release of the flexor hallucis longus tendon at the posterior ankle for management of checkrein deformity of the great toe, second toe, and third toe of the right foot. The patient is in the prone position. This procedure is performed with the posteromedial and posterolateral portals. The posterolateral portal is located at the lateral side of the Achilles tendon just above the posterior calcaneal tubercle. The posteromedial portal is located at the intersection point between the medial border of the Achilles tendon and the line joining the undersurface of the sustentaculum tali and first metatarsal. (PLP, posterolateral portal; PMP, posteromedial portal.)

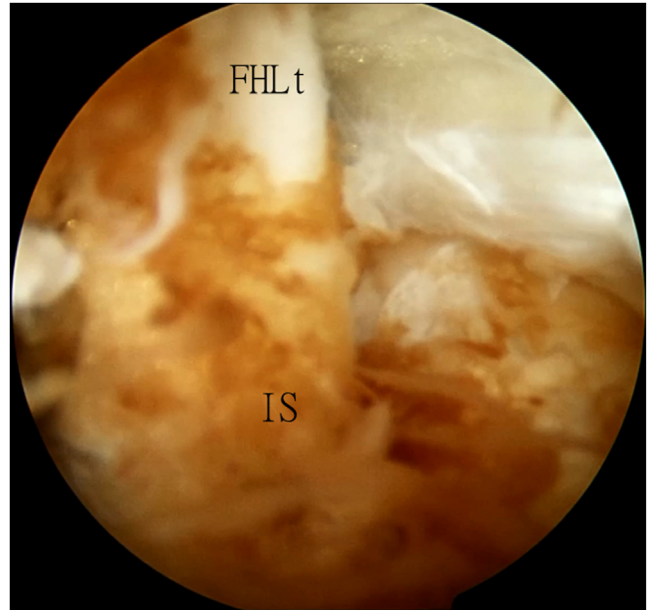


Fig 5. Endoscopic release of the flexor hallucis longus tendon at the posterior ankle for management of checkrein deformity of the great toe, second toe, and third toe of the right foot. The patient is in the prone position. The posterolateral portal is the viewing portal and the posteromedial portal is the working portal. Endoscopic synovectomy of the posterior ankle is performed. (FHLt, flexor hallucis longus tendon; IS, inflamed synovium.)

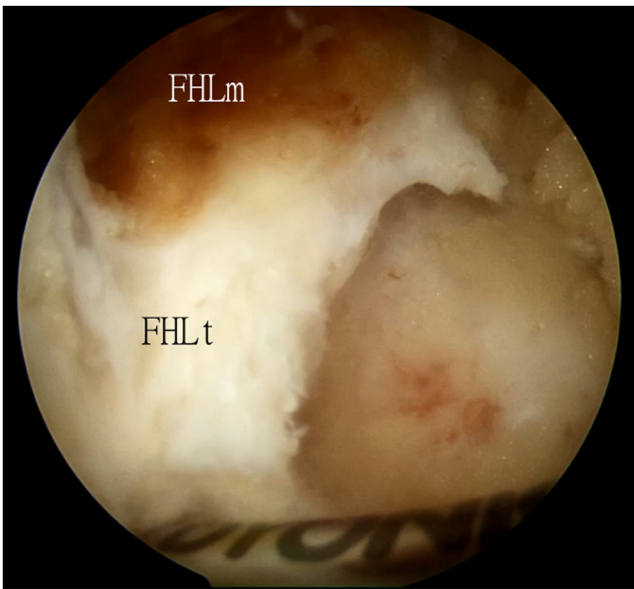


Fig 4. Endoscopic release of the flexor hallucis longus tendon at the posterior ankle for management of checkrein deformity of the great toe, second toe, and third toe of the right foot. The patient is in the prone position. The posteromedial portal is the viewing portal and the posterolateral portal is the working portal. The fibrous tissue at the posterior ankle is carefully resection with an arthroscopic shaver to expose the flexor hallucis longus tendon and muscle. (FHLm, flexor hallucis longus muscle; FHLt, flexor hallucis longus tendon.)

Endoscopic Adhesiolysis and Synovectomy of the FHL Tendon

The posteromedial portal is the viewing portal and the posterolateral portal is the working portal. The fibrous tissue at the posterior ankle is carefully resection with an arthroscopic shaver (Dyonics; Smith and Nephew) to expose the FHL tendon and muscle (Fig 4). The procedure should be performed under direct endoscopic visualization and started at the lateral side of the posterior ankle. After the FHL tendon is exposed, the fibrous adhesions around the tendon are carefully resected. The portals can be interchanged as viewing and working portals to achieve circumferential adhesiolysis of the tendon. If synovitis is present at the posterior ankle, endoscopic synovectomy is performed (Fig 5). Any correction of the checkrein deformity is checked. If the deformity persists, endoscopic adhesiolysis of the FHL muscle is performed.

Endoscopic Adhesiolysis of the FHL Muscle

The posteromedial portal is the viewing portal and the posterolateral portal is the working portal. The FHL tendon is traced proximally to identify the FHL muscle. The fibrous adhesions around the FHL muscle are released by an arthroscopic shaver and SuperCut scissors (Stille) (Fig 6). The endoscopic release of the muscle proceeds proximally as far as possible. Any

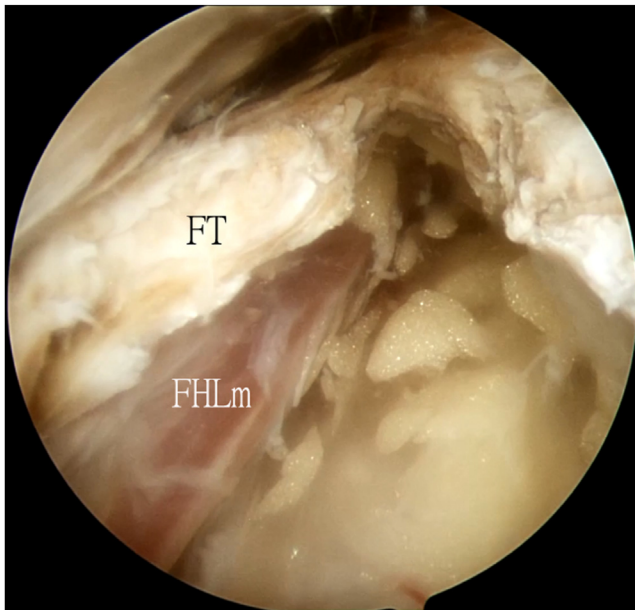


Fig 6. Endoscopic release of the flexor hallucis longus (FHL) tendon at the posterior ankle for management of checkrein deformity of the great toe, second toe, and third toe of the right foot. The patient is in the prone position. The posteromedial portal is the viewing portal and the posterolateral portal is the working portal. The FHL tendon is traced proximally to identify the FHL muscle. The fibrous adhesions around the FHL muscle are released by an arthroscopic shaver and SuperCut scissors. (FHLm, flexor hallucis longus muscle; FT, fibrotic tissue.)

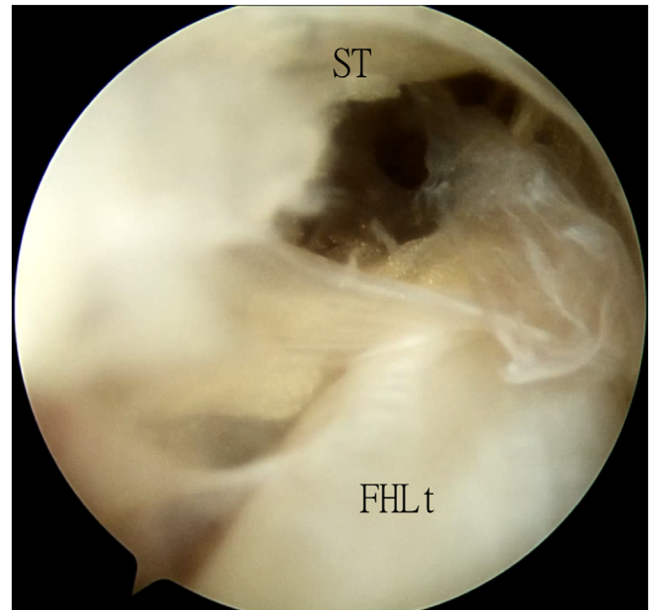


Fig 7. Endoscopic release of the flexor hallucis longus (FHL) tendon at the posterior ankle for management of checkrein deformity of the great toe, second toe, and third toe of the right foot. The patient is in the prone position. The posteromedial portal is the viewing portal. Zone 2 FHL tendoscopy is performed and the zone 2 FHL is examined. (FHLt, flexor hallucis longus tendon; ST, sustentaculum tali.)

correction of the checkrein deformity is checked again. If the deformity persists, this is suggestive of extensive fibrosis of the muscle, and endoscopic tenotomy of the FHL tendon is indicated.

Zone 2 FHL Tendoscopy

The FHL tendon can be divided into 3 zones: zone 1 FHL tendon is at the posterior ankle, zone 2 FHL tendon is at the hindfoot and midfoot down to the master knot of Henry, and zone 3 FHL tendon is distal to the master knot of Henry.^{15,17,18} Before zone 1 FHL tenotomy, zone 2 FHL tendoscopy is performed to exclude any fibrous adhesions of the zone 2 FHL tendon.

The ankle is slightly plantarflexed to relax the neurovascular bundle during the zone 2 FHL tendoscopy.¹⁹ The posterolateral portal is the viewing portal and the FHL tendon is traced distally to the fibro-osseous orifice at the posterior talar tubercle. A 4-mm Wissinger rod (Dyonics; Smith and Nephew) is inserted via the posteromedial portal into the zone 2 tendon sheath under the sustentaculum tali. The arthroscope-cannula is then inserted along the rod, and the rod is removed and replaced by the arthroscope. The posteromedial portal becomes the viewing portal of the zone 2 FHL tendoscopy, and the zone 2 FHL is examined (Fig 7).

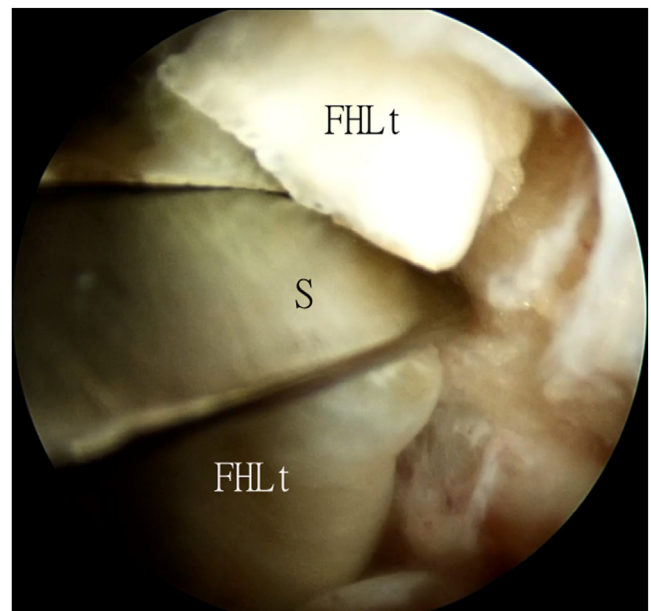


Fig 8. Endoscopic release of the flexor hallucis longus tendon at the posterior ankle for management of checkrein deformity of the great toe, second toe, and third toe of the right foot. The patient is in the prone position. The posterolateral portal is the viewing portal and the posteromedial portal is the working portal. The zone 1 flexor hallucis longus tendon is cut with SuperCut scissors. (FHLt, flexor hallucis longus tendon; S, scissiors.)

Table 2. Pearls and Pitfalls of Endoscopic Release of the Flexor Hallucis Longus (FHL) Tendon at the Posterior Ankle for Management of Checkrein Deformity of the Great Toe, Second Toe, and Third Toe

Pearls	Pitfalls
During the adhesiolysis of the medial side of the FHL tendon and muscle, the shaver blade should not face medially and the suction should be kept at a minimum. The medial release should be under direct endoscopic visualization to minimize the risk of injury to the posterior tibial neurovascular bundle.	If fibrous adhesions of zone 2 FHL tendon are present, zone 1 FHL tenotomy cannot correct the checkrein deformities.
The ankle is slightly plantarflexed to relax the neurovascular bundle during the zone 2 FHL tenoscopy.	

Zone 1 FHL Endoscopic Tenotomy

The posterolateral portal is the viewing portal and the posteromedial portal is the working portal. The zone 1 FHL tendon is cut with the SuperCut scissors (Fig 8, Video 1, Table 2). Active and passive mobilization of the ankle and the toes can be started from postoperative day 1 (Fig 9).

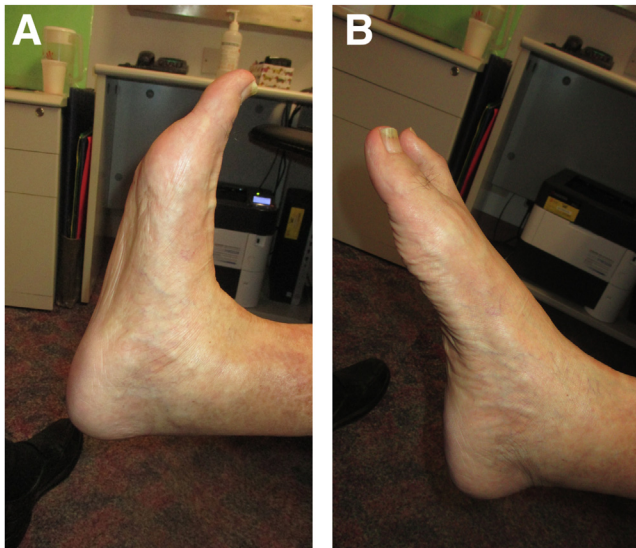


Fig 9. Endoscopic release of the flexor hallucis longus tendon at the posterior ankle for management of checkrein deformity of the great toe, second toe, and third toe of the right foot. The patient is in the prone position. (A) The checkrein deformity is corrected after endoscopic flexor hallucis longus tenotomy. (B) The active plantarflexion of the hallux interphalangeal joint is lost.

Table 3. Advantages and Risks of Endoscopic Release of the Flexor Hallucis Longus (FHL) Tendon at the Posterior Ankle for Management of Checkrein Deformity of the Great Toe, Second Toe, and Third Toe

Advantages	Risks
Smaller wounds and better cosmetic result	Loss of the FHL action
Minimal soft tissue dissection	Injury to the posterior tibial neurovascular bundle
Early mobilization allowed	Recurrence of the deformity

Discussion

The distal third and fourth portion of the FHL muscle locates in a more compressed and deeper compartment and can be involved in subclinical compartment syndrome of the distal deep posterior compartment of the leg.^{9,10,20-22} This can result in fibrosis of the distal part of the FHL muscle and adhesion to the surrounding structures, resulting in checkrein deformity of the hallux.^{9,23} This condition is feasible for endoscopic release of the FHL muscle.^{24,25} Although tendon lengthening or tenotomy can correct deformities, toe flexion function may be partially lost.¹ On the other hand, if the deformities are caused by adhesion, the basic function of toes can be restored through in situ release.¹ Therefore, we attempt endoscopic adhesiolysis before considering tenotomy. FHL tenotomy is performed only if the deformity persists after adhesiolysis. Endoscopic zone 1 FHL tenotomy is preferred to Z-plasty because it is a simpler technique and immediate mobilization of the ankle and toes is allowed. Moreover, FHL tenotomy proximal to the master knot of Henry can relieve the tensions of the distal FHL and FDL tendons and correct deformity of the hallux and second and third toes. If FHL tenotomy is performed at the toe level, the second and third toe deformities may be exacerbated as all the FHL muscle pull will be transmitted to the FDL tendons of the second and third toes via the master knot of Henry.

The potential advantages of this technique include smaller wounds and better cosmetic result, minimal soft tissue dissection, and early mobilization allowed. The potential risks of this technique include loss of the FHL action, injury to the posterior tibial neurovascular bundle, and recurrence of the deformity (Table 3). This technique is not technically demanding and can be performed by average foot and ankle arthroscopist.

Disclosures

The authors report no conflicts of interest in the authorship and publication of this article. Full ICMJE author disclosure forms are available for this article online, as [supplementary material](#).

References

1. Yuan Y, Gao J, Jia J. Application of ultrasound in preoperative localization diagnosis of checkrein deformity: A retrospective case series. *J Orthop Surg* 2023;31:10225536231189783.
2. Gadhavi MV, Majmundar DD, Solanki RA. Checkrein deformity of the great toe managed by midfoot flexor hallucis longus Z-plasty: A case report. *J Orthop Case Rep* 2019;9:18-20.
3. Rodriguez-Collell JR, Mifsut-Miedes D. Checkrein deformity of the hallux and second toe after soft-tissue injury. *Case Reports Orthop* 2021;8459586.
4. Leitschuh PH, Zimmerman JP, Uhorchak JM, Arciero RA, Bowser L. Hallux flexion deformity secondary to entrapment of the flexor hallucis longus tendon after fibular fracture. *Foot Ankle Int* 1995;16:232-235.
5. Tanwar YS, Singh S, Arya RK, Aujla N, Mathur A, Kharbanda Y. A closed lateral subtalar dislocation with checkrein deformity of great toe due to entrapment of flexor hallucis longus. *Foot Ankle Spec* 2016;9:461-464.
6. Carr JB. Complications of calcaneus fractures entrapment of the flexor hallucis longus: Report of two cases. *J Orthop Trauma* 1990;4:166-168.
7. Won SH, Kim SH, Lee YK, Chun DI, Lee BR, Kim WJ. A neglected extensor hallucis longus tendon rupture caused by arthritic adhesion. *Medicina* 2023;59:1069.
8. Polichetti C, Greco T, Inverso M, Maccauro G, Forconi F, Perisano C. Retro-malleolar Z-plasty of flexor hallucis longus tendon in post-traumatic checkrein deformity: A case series and literature review. *Medicina* 2022;58:1072.
9. Fitoussi F, Ilharreborde B, Guerin F, Souchet P, Pennecot GF, Mazda K. Claw toes after tibial fracture in children. *J Child Orthop* 2009;3:339-343.
10. Hernandez-Cortes P, Pajares-Lopez M, Hernandez-Hernandez MA. Ischemic contracture of deep posterior compartment of the leg following isolated ankle fracture. *J Am Podiatr Med Assoc* 2008;98:404-407.
11. Burda R, Morochovic R, Kitka M. Hallux flexus—The result of posttraumatic entrapment of the flexor hallucis longus tendon in the tibial fracture site. *Rozhl Chir* 2010;89:466-467.
12. Yuen CP, Lui TH. Adhesion of flexor hallucis longus at the site of a tibial-shaft fracture—A cause of a checkrein deformity. *Foot Ankle Surg* 2015;21:e23-e26.
13. Holcomb TM, Temple EW, Barp EA, Smith HL. Surgical correction of checkrein deformity after malunited distal tibia fracture: A case report. *J Foot Ankle Surg* 2014;53:631-634.
14. Lee HS, Kim JS, Park SS, Lee DH, Park JM, Wapner KL. Treatment of checkrein deformity of the hallux. *J Bone Joint Surg Br* 2008;90:1055-1058.
15. Lui TH. Flexor hallucis longus tendoscopy: A technical note. *Knee Surg Sports Traumatol Arthrosc* 2009;17:107-110.
16. Lui TH. Endoscopic assisted flexor hallucis tendon transfer in the management of chronic rupture of Achilles tendon. *Knee Surg Sports Traumatol Arthrosc* 2007;15:1163-1166.
17. Lui TH, Chan KB, Chan LK. Zone 2 flexor hallucis longus tendoscopy: A cadaveric study. *Foot Ankle Int* 2009;30:447-451.
18. Lui TH, Chan KB, Chan LK. Cadaveric study of zone 2 flexor hallucis longus tendon sheath. *Arthroscopy* 2010;26:808-812.
19. Lui TH. Lateral plantar nerve neuropraxia after FHL tendoscopy: Case report and anatomic evaluation. *Foot Ankle Int* 2010;31:828-831.
20. Kwiatkowski TC, Detmer DE. Anatomical dissection of the deep posterior compartment and its correlation with clinical reports of chronic compartment syndrome involving the deep posterior compartment. *Clin Anat* 1997;10:104-111.
21. Piper KJ, Yen-yi JC, Horsley M. Missed posterior deep, inferior subcompartment syndrome in a patient with an ankle fracture: A case report. *J Foot Ankle Surg* 2010;49:398.e5-398.e8.
22. Sassu P, Acland RD, Salgado CJ, Mardini S, Ozyurekoglu T. Anatomy and vascularization of the flexor hallucis longus muscle and its implication in free fibula flap transfer. An anatomical study. *Ann Plast Surg* 2010;64:233-237.
23. Rosenberg GA, Sferra JJ. Checkrein deformity—An unusual complication associated with a closed Salter-Harris Type II ankle fracture: A case report. *Foot Ankle Int* 1999;20:591-594.
24. Lui TH. Endoscopic adhesiolysis of the flexor hallucis longus muscle. *Foot Ankle Spec* 2014;7:492-494.
25. Lui TH. Endoscopic adhesiolysis of flexor hallucis longus muscle. *Arthrosc Tech* 2017;6:e325-e329.