

Z-plasty of the flexor hallucis longus tendon at tarsal tunnel for checkrein deformity

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ABSTRACT

Purposes. To review the outcome of Z-plasty of the flexor hallucis longus (FHL) tendon at the tarsal tunnel for checkrein deformity in 8 patients.

Methods. Records of 6 males and 2 females aged 14 to 67 (mean, 39.5) years who underwent Z-plasty (lengthening) of the FHL tendon at the tarsal tunnel for checkrein deformity in the first and second toes by a single surgeon were reviewed. All patients had undergone 3 months of conservative treatment. The mean time from injury to surgical treatment was 8.4 (range, 5–12) months. All patients had associated injuries including distal tibiofibular fracture (n=6), distal fibular fracture (n=1), and crush injury around the ankle (n=1); they were treated with intramedullary nailing (n=6), long leg splinting (n=1), and short leg splinting (n=1).

Results. After a mean follow-up of 3.4 (range, 1–7) years, the FHL tendon was lengthened by a mean of 1.7 (range, 1.6–1.8) cm, and the mean American Orthopedic Foot and Ankle Society hallux score increased from 59 (range, 52–67) to 89 (range, 80–90). No patient had recurrence, nerve injury, or tarsal tunnel syndrome, although one patient had sensory disturbance of the posterior tibial nerve in the forefoot, which resolved spontaneously at week 2.

Conclusion. Z-plasty of the FHL tendon at the tarsal tunnel is a viable option for correction of checkrein deformity.

Key words: foot deformities, acquired; tendons

INTRODUCTION

A checkrein deformity is characterised by flexion contracture at the interphalangeal joint with extension contracture of the metatarsophalangeal joint of the first and second toes. It is caused by entrapment or fixed tethering of the flexor hallucis longus (FHL) tendon in the posterior foot, proximal to the flexor retinaculum of the ankle.^{1–3} Passive dorsiflexion about the ankle increases deformity at the hallux, and plantar flexion at the ankle partially corrects the deformity.³ It can occur after non-operative or operative treatment for distal tibial, fibular, calcaneal, or talar fracture; after removal of fibular grafts; or secondary to compartment syndrome.^{1–5}

Surgical treatment includes simple release of adhesions^{6,7} and Z-plasty (lengthening) of the FHL tendon at the posterior aspect of the ankle,^{5,8} Z-plasty (lengthening) of the FHL tendon at the midfoot^{3,8} and tenotomy at the interphalangeal joint.^{9,10} The optimal method has not been identified.⁹ This study reviewed the outcome of Z-plasty of the FHL tendon at tarsal

tunnel for checkrein deformity in 8 patients.

MATERIALS AND METHODS

Records of 6 males and 2 females aged 14 to 67 (mean, 39.5) years who underwent Z-plasty (lengthening) of the FHL tendon at the tarsal tunnel for checkrein deformity in the first and second toes (Fig. 1) by a single surgeon between June 2006 and January 2014 were reviewed. All patients had had 3 months of conservative treatment. The mean time from injury to surgical treatment was 8.4 (range, 5–12) months. All patients had associated injuries including distal tibiofibular fracture ($n=6$, 2 of them were open), distal fibular fracture ($n=1$), and crush injury around the ankle ($n=1$); they were treated with intramedullary nailing ($n=6$) by different surgeons, long leg splinting ($n=1$), and short leg splinting ($n=1$).

The patient was placed in a supine position. An incision was made along the tarsal tunnel. The subcutaneous tissue was dissected and the flexor retinaculum was exposed, taking care not to damage the neurovascular structures. During traction of the neurovascular bundle consisting of the posterior tibial nerve and tibial artery posteriorly, a cutaneous branch running anteriorly from the anterior tibial artery was ligated. When the neurovascular bundle was pulled posteriorly, a tendon sheath was identified

and opened to expose the FHL tendon (Fig. 2a). After about 3 cm of FHL tendon was exposed, Z-plasty was performed and the first and second toes were passively extended (Fig. 2b). With the ankle located 90° and the first and second toes in a neutral position, Z-plasty of the FHL tendon was completed using the 4/0 ethibond (Figs. 2c and 2d). The tourniquet was released, and the skin was sutured with 4/0 nylon. A short leg splint was applied with the ankle in a neutral position including the toes and maintained for 3 weeks, after which the splint was removed, and ambulation was allowed.

Outcome was assessed by a single assessor in terms of neurological symptoms, American Orthopedic Foot and Ankle Society (AOFAS) hallux score, and recurrence of claw toe deformity. Preoperative and final AOFAS scores were compared using the Wilcoxon signed rank test. A p value of <0.05 was considered statistically significant.

RESULTS

After a mean follow-up of 3.4 (range, 1–7) years, the FHL tendon was lengthened by a mean of 1.7 (range, 1.6–1.8) cm, and the mean AOFAS hallux score increased from 59 (range, 52–67) to 89 (range, 80–90) [Table]. No patient had recurrence, nerve injury, or tarsal tunnel syndrome, although one patient



Figure 1 Preoperatively, (a) checkrein deformity at dorsiflexion and (b) resolution of tethering of the flexor hallucis longus tendon at plantar flexion. At postoperatively one year, correction of deformity at (c) ankle dorsiflexion and (d) affected toes further flexed at plantar flexion of ankle.

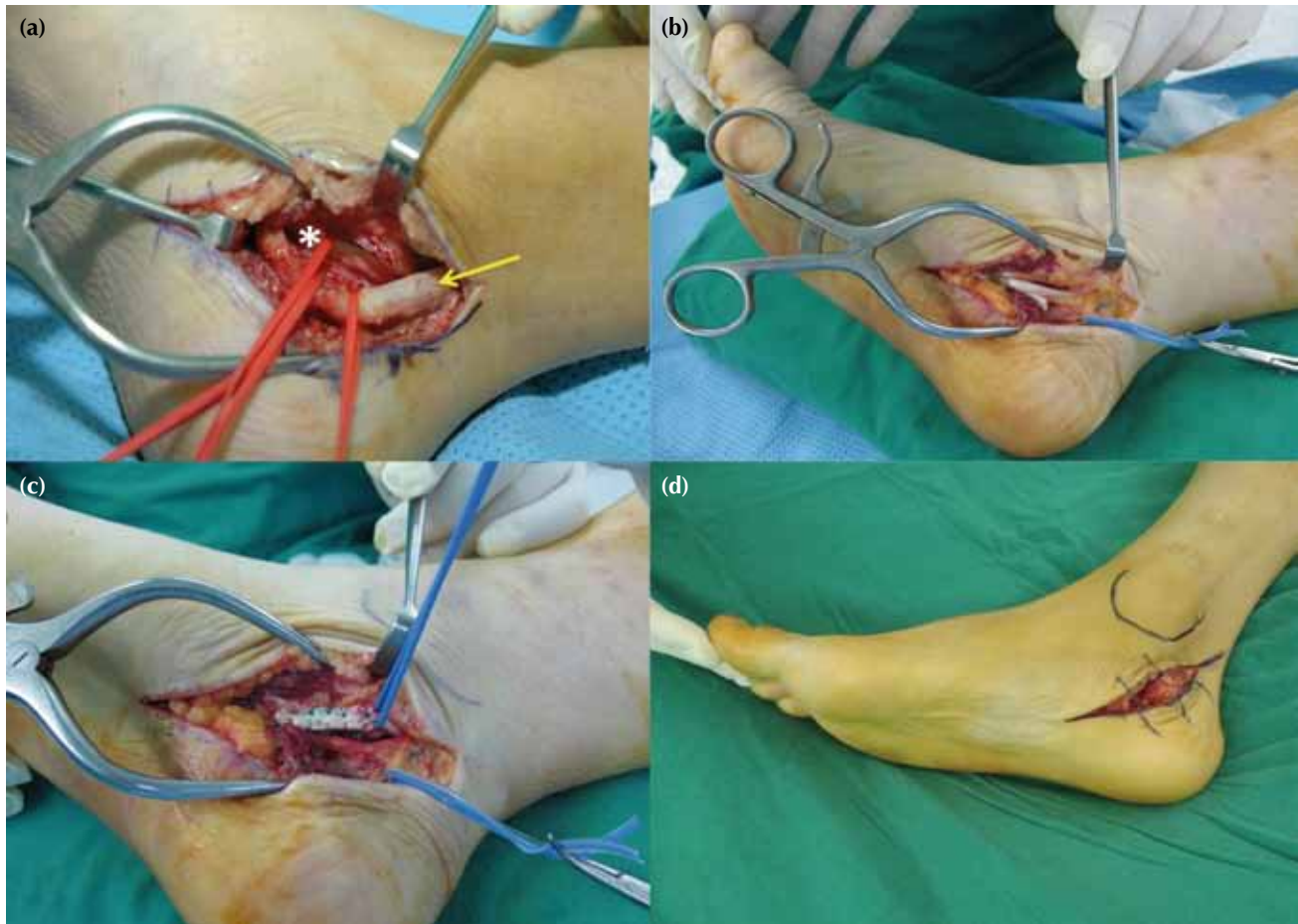


Figure 2 (a) The neurovascular bundle (asterisk) and flexor hallucis longus (FHL) tendon (arrow) are identified at tarsal tunnel. (b) After Z-plasty, the affected toes are extended passively at ankle dorsiflexion. (c) The FHL tendon is sutured using the 4/0 ethibond at tarsal tunnel. (d) Correction of checkrein deformity after FHL tendon-lengthening.

had sensory disturbance caused by traction of the posterior tibial nerve in the forefoot; the disturbance resolved spontaneously at week 2.

DISCUSSION

Complete correction of deformity with no recurrence has been reported after lengthening of the FHL tendon alone or the FHL and flexor digitorum longus (FDL) tendons combined with a retromalleolar incision.⁵ Recurrence has been reported at one year in 2 of 5 patients after tenolysis of the FHL and FDL tendons combined with lengthening of the FHL tendon at the musculotendinous junction.¹⁰ Additional lengthening of the FDL tendon has been necessary when lengthening of the FHL tendon alone does not correct deformity in the retromalleolar region.⁵ In 5 patients with Z-plasty lengthening at the musculotendinous junction at a fracture site and 6 patients with

lengthening of the FHL tendon at the midfoot, 3 of the former patients developed recurrence and one required a secondary operation, but none of the latter patients developed recurrence.⁸ Thus, lengthening of the FHL tendon at the midfoot is recommended, as it has a lower risk of adhesion recurrence.⁸ For correction of checkrein deformity at the midfoot, an additional operation to separate the FDL tendon attached to the FHL tendon is required with lengthening of the FHL tendon. This is necessary because the intertendinous connection between the FDL and FHL tendons at the midfoot does not allow correction of deformity in the second toe with lengthening of the FHL tendon alone.

Lengthening of the FHL tendon using a retromalleolar incision may lead to recurrence, and lengthening of the FHL tendon at the midfoot requires an additional operation for disconnection between the FHL and FDL tendons. In our patients, lengthening of the FHL tendon alone was performed at the tarsal tunnel. All patients achieved complete correction of

Table
Patient characteristics and outcome

Sex/ age (years)	Injury side	Associated injury	Treatment	Follow- up (years)	Flexor hallucis longus tendon lengthening (cm)	American Orthopedic Foot and Ankle Society hallux score		Com- plication
						Preop	Follow-up	
M/52	Right	Crushing injury at distal tibia	Short-leg splinting	1	1.6	57	90	No
M/14	Left	Distal tibiofibular fracture	Long-leg casting	6.2	1.6	62	90	No
M/58	Right	Distal fibular fracture	Intramedullary nailing	3.5	1.7	52	90	Transient neuropraxia
M/67	Right	Open distal tibiofibular fracture	Intramedullary nailing	4.2	1.8	62	90	No
F/22	Left	Open distal tibiofibular fracture	Intramedullary nailing	7	1.7	52	80	No
M/19	Left	Distal tibiofibular fracture	Intramedullary nailing	1.2	1.8	62	90	No
M/48		Distal tibiofibular fracture	Intramedullary nailing	2.4	1.6	57	90	No
F/36	Left	Distal tibiofibular fracture	Intramedullary nailing	1.8	1.8	67	90	No

the first and second toes, with the tendon lengthened by a mean of 1.7 cm.

Z-plasty (lengthening) of the FHL tendon at the tarsal tunnel results in a lower recurrence rate than a retromalleolar release. Lengthening of the FHL tendon at the retromalleolar area may lead to adhesion and recurrence, because the retromalleolar area is a musculotendinous junction of the FHL tendon and close to the injury site. Nonetheless, the FHL tendon in the tarsal tunnel is surrounded by the tendon sheath and far from the injury site, and the tendon sheath of the FHL should be opened for Z-plasty. This may decrease the risk of adhesion to adjacent tissues. In addition, Z-plasty of the FHL tendon at the tarsal tunnel may lead to more powerful walking, compared with tenotomy of the FHL at the level of the base of the toe, because the FHL tendon is not torn but connected after Z-plasty. Moreover, lengthening of the FHL tendon alone may

resolve deformity in the first and second toes. One disadvantage of the procedure is that meticulous dissection of soft tissue is needed to prevent injury to the neurovascular bundle. Nonetheless, when the neurovascular bundle is pulled posteriorly, the FHL tendon is easily exposed, allowing surgeons to achieve 2 cm lengthening and rigid tenorrhaphy, which makes early toe movement possible.

CONCLUSION

Z-plasty of the FHL tendon at the tarsal tunnel is a viable option for correction of checkrein deformity.

DISCLOSURE

No conflicts of interest were declared by the authors.

REFERENCES

- Kim SH, Lee KT, Smith RW, Park YU. Checkrein deformity secondary to entrapment of FHL after talus fracture: a case report. *Foot Ankle Int* 2010;31:336–8.
- Rosenberg GA, Sfera JJ. Checkrein deformity—an unusual complication associated with a closed Salter-Harris Type II ankle fracture: a case report. *Foot Ankle Int* 1999;20:591–4.
- Sanhudo JA, Lompa PA. Checkrein deformity—flexor hallucis tethering: two case reports. *Foot Ankle Int* 2002;23:799–800.
- Carr JB. Complications of calcaneus fractures entrapment of the flexor hallucis longus: report of two cases. *J Orthop Trauma* 1990;4:166–8.
- Feeney MS, Williams RL, Stephens MM. Selective lengthening of the proximal flexor tendon in the management of acquired claw toes. *J Bone Joint Surg Br* 2001;83:335–8.
- 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;16:232–5.
- Lui TH. Flexor hallucis longus to extensor hallucis longus transfer for correction of hallux flexus deformity. *Foot Ankle Int* 2013;34:1456–59.
- 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;90:1055–8.
- 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;53:631–4.
- Tsai KW. Checkrein deformity following tibial fractures: a report of five cases. *J Orthop Surg (Hong Kong)* 2001;18:193–7.