



Selective lengthening of the proximal flexor tendon in the management of acquired claw toes

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We report the management of the acquired claw-toe deformity in ten adults. Each patient developed a varying number of claw toes at a mean interval of six months after the time of injury. There was clinical evidence of an acute compartment syndrome in one case. The clawing occurred at the start of heel-rise in the stance phase of gait. At this stage the patients complained of increasing pain and pressure on the tips of the toes.

The deformities were corrected by lengthening flexor hallucis longus and flexor digitorum longus alone or in combination. The presence of variable intertendinous digitations between the tendons of flexor hallucis longus and flexor digitorum longus means that in some cases release of flexor hallucis longus alone may correct clawing of lesser toes.

*J Bone Joint Surg [Br] 2001;83-B:335-8.
Received 4 July 2000; Accepted after revision 24 October 2000*

Acquired clawing of the toes may be due to contracture of the muscles of the deep posterior compartment of the leg after a compartment syndrome. This produces a 'fixed-length phenomenon' of the long toe flexors, also described as a 'checkrein' deformity.¹ In a similar manner a contracture of tibialis posterior may cause pes cavus.²

If clawing develops after injury without an overt compartment syndrome, the implication is that either there has been a subclinical deep compartment syndrome, or that the muscle bellies of the tendons have been injured or trapped at the site of the fracture or scarred after a local haematoma. If tibialis posterior is not affected, the aetiology is more likely to be due to causes other than a compartment syndrome.

We report ten patients with acquired clawing of the toes, and discuss the aetiology, clinical findings, the influence of anatomical variants and management.

Patients and Methods

We reviewed ten patients (eight men) with a mean age of 27 years (21 to 53) in clinics at two hospitals. All presented with symptoms referable to painful clawed toes with disturbance of gait and discomfort in shoes. The eight men all had had a fractured shaft of the tibia in the same leg before the onset of clawing of the toes. One woman had bilateral symptoms which followed abdominal surgery. She had been in the lithotomy position with ankle straps for a prolonged period, under hypotensive anaesthesia. One man had an obvious acute post-traumatic compartment syndrome. All the tibial fractures had been treated by intramedullary nailing. The mean onset of clawing was at six months (3 to 9) after injury.

On examination, each patient had a variable number of affected toes (Table I). With clawing of the hallux there was a flexion contracture of the interphalangeal joint with a dorsal callosity. The affected lesser toes had a flexion deformity at both the proximal and distal interphalangeal joints, with a variable amount of overlying callus on the dorsum and tip of the toes.

When the ankle was passively plantar flexed, the deformity became fully flexible and completely corrected, but when passively dorsiflexed clawing became more prominent and fixed (rigid) due to the 'fixed length phenomenon' of the long flexors (Figs 1 and 2). This explained the patients' complaint of pain in the tips of the clawed toes soon after heel-rise in the stance phase of the gait cycle. Because of tethering and the fixed length of flexor hallucis longus (FHL) and/or flexor digitorum longus (FDL) the toes cannot dorsiflex to allow the normal rocker movement at the metatarsophalangeal joints.

Operative technique. Each operation was carried out under general anaesthesia, with a tourniquet. The long flexor tendons were approached through a longitudinal retromalleolar incision which was extended proximally along the posteromedial border of the tibia. The superficial posterior compartment was opened, and then the deep, as they blend with the tibial periosteum. The FDL and FHL

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0301-620X/01/311506 \$2.00

Table I. Details of the ten patients with acquired clawing of the toes

Case	Age at time of tendon surgery (yr)	Gender	Tibial fracture	Mechanism of injury or other surgery	Fracture management*	Acute compartment syndrome	Onset of clawing after initial surgery (mth)	Affected toes (1 = hallux, 5 = little toe)	Motor deficit	Tendons lengthened
1	22	F	None	Prolonged lithotomy position	N/A	No	6	1,2 (bilateral)	No	FHL + tarsal tunnel decompression (bilateral)
2	23	M	Closed middle 1/3	RTA†	Locked IM nail	No	8	2 to 5	No	FDL
3	35	M	Open middle 1/3	Fall	Wound debridement, Locked IM nail	No	6	1 to 5	No	FHL+FDL
4	28	M	Closed proximal 1/3	RTA	Locked IM nail	No	7	1 to 3	No	FHL
5	53	F	None	Varicose vein surgery	N/A	No	6	1 to 5	No	FHL+FDL
6	22	M	Closed middle 1/3	RTA	Locked IM nail	Yes	3	1,2	Weak FDL and FHL	FHL
7	21	M	Closed proximal 1/3	RTA	Locked IM nail	No	9	1 to 4	No	FHL+FDL
8	22	M	Closed middle 1/3	RTA	Locked IM nail	No	6	1 to 5	No	FHL+FDL
9	20	M	Closed middle 1/3	RTA	Locked IM nail	No	9	1 to 4	No	FHL+FDL
10	22	M	Closed middle 1/3	Football	Locked IM nail	No	4	1 to 3	No	FHL

* IM, intramedullary; N/A, not applicable

† road-traffic accident



Fig. 1

Photograph showing complete correction of clawing of all five toes when the ankle is passively plantar flexed.



Fig. 2

When the ankle is brought into dorsiflexion, clawing becomes prominent and fixed.

could then be identified in the posterior portion of the wound, and dissected free for a length of 5 to 7 cm. In this way the neurovascular bundle remained posterior and was protected from injury. The appropriate tendon or tendons were lengthened using a Z-technique and repaired with the foot in maximum dorsiflexion and all toes held in extension at the metatarsophalangeal and interphalangeal joints (Fig. 3). In this position the tendon(s) were sutured at the correct length. A walking cast, with an extended sole to maintain extension of the toes, was applied for four weeks.

Results

Four patients, including the woman who had bilateral procedures, had release of FHL alone. Five patients needed release of FDL and FHL. One required release of FDL alone. There were no postoperative complications. All patients had full correction of all clawed toes. At follow-up at a minimum of 12 months (12 to 20), all patients reported relief from pain, ease of shoe-fitting and subjective improvement of gait. There was no recurrence of the deformity.

Discussion

Clawing of the toes can be a complication of deep posterior compartment syndrome of the leg,³⁻⁵ usually in association with other deformities of the foot. Delayed or inadequate treatment of acute compartment syndrome is implicated in



Fig. 3

Intraoperative photograph, showing correction of clawing in dorsiflexion, after division of the FHL tendon.

many cases.^{5,6} The development and natural history of compartment syndrome after injury to the lower limb are well documented.^{5,7-9} The need for prompt diagnosis and fasciotomy in the acute case has been well accepted,^{5,10-12} although little has been written of the late complications of minor or borderline compartment syndrome.²

Our patients, however, pose a problem as to aetiology, because in nine of the ten there was no clinical compartment syndrome. One explanation could be that they had developed a subclinical compartment syndrome, which is hypothetical and has not yet been reported in the literature. Borderline cases of compartment syndrome may be difficult to diagnose without a high index of suspicion and early monitoring of compartment pressure. Gulli and Templeman¹³ point out that the criteria for diagnosis are somewhat subjective, not uniformly present and are often difficult to assess. Even the development of clawing of the toes as a late consequence of a minor or borderline compartment syndrome may be overlooked.^{2,14} This may be explained by the dynamic nature of the claw deformity, as described by Clawson.³ None of our patients had a fixed deformity when the ankle was fully plantar flexed, and dynamic toe clawing was reproducible only on passive dorsiflexion of the ankle, when it became fixed. The absence of any contracture of tibialis posterior suggests that the aetiology is different from that of compartment syndrome.

An alternative explanation could be that the condition is caused by tethering or scarring of the muscle bellies at the site of a fracture. Jahss¹ noted that the hallux may become clawed after fractures of the ankle and distal tibia, because of tethering of the FHL tendon under or just proximal to the flexor retinaculum (the 'checkrein' deformity). He advocated tenolysis and lengthening of FHL at the retromalleolar level, with resort to interphalangeal joint fusion of the hallux in the case of incomplete correction or recurrent deformity. Such examples have been reported infrequently in the literature.^{15,16} This mechanism could explain the

aetiology of most of the cases in our series, but does not account for the claw deformities in one patient who had no fractures. There are no reports of the conservative treatment of this condition. In theory, a rocker sole with its apex at the metatarsophalangeal joint may give some symptomatic relief. In view of the relative fixed deformity when the ankle is dorsiflexed, and the relative ease with which surgery can be carried out, surgical treatment was thought to be the treatment of choice.

All patients in our series showed improvement in their symptoms after lengthening of one or both long toe flexors at the level of the medial malleolus. It was notable that four patients required lengthening of the FHL tendon alone because it corrected the clawing of the lesser toes. This is explained by the variable anatomy of the long flexors to the toes, which has been fully documented.¹⁷ Almost invariably, there is a tendinous connection from FHL to FDL (Fig. 4). The connection seems constant to the FDL slip to the second toe, while interdigitations extend to the third, fourth and fifth toes with varying frequency. Less commonly, there is a tendinous connection from FDL to FHL. These connections therefore ultimately determine whether lengthening of FHL alone will suffice or whether FDL requires concomitant lengthening. When the clawing seems to involve predominantly the lesser toes, FDL should be lengthened first and the surgeon should then reassess the

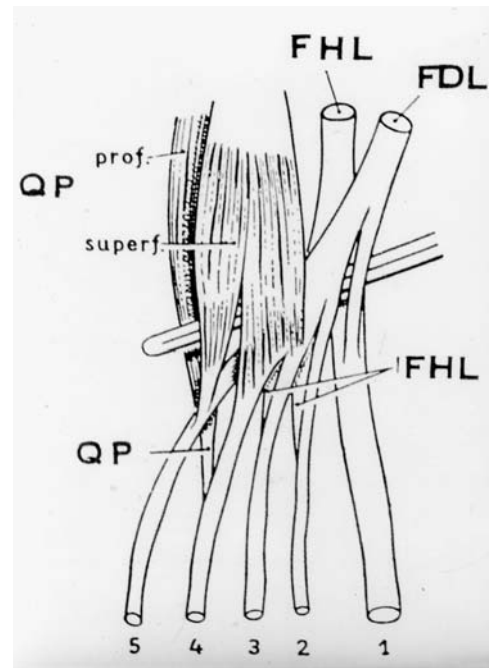


Fig. 4

Diagram showing the tendinous interconnections of the FHL and the FDL. In this example FHL provides an extension to the tendons of FDL to the second and third toes, while FDL provides a tendinous band to FHL (QP, quadratus plantae). (Reproduced with permission from Sarrafian SK. *Anatomy of the foot and ankle: descriptive, topographic, functional*. Second ed., Philadelphia: Lippincott, Williams & Wilkins, 1993:252.)

deformity. If it is not completely corrected, FHL should be lengthened at the same time. Conversely, if clawing of the hallux is present, FHL must be lengthened first, and only if there is persistent clawing of the lesser toes on maximum passive ankle dorsiflexion should FDL be lengthened.

Patients with closed tibial fractures, or with minor or undiagnosed deep posterior compartment syndromes, may present late with dynamic clawing of the toes. This responds well to lengthening of the involved long toe flexors at a retromalleolar level, rather than to soft-tissue or fusion procedures on the individual digits.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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