Flexor Tenotomy For Contracted Toe Deformities

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Disclosure

Nothing to declare

Learning objectives

- Define the common lesser digital deformities
- Review Anatomy
- Describe their pathomechanics
- Describe flexor and extensor tenotomies
- Capsular releases

Classification of digital deformities

Structure/function

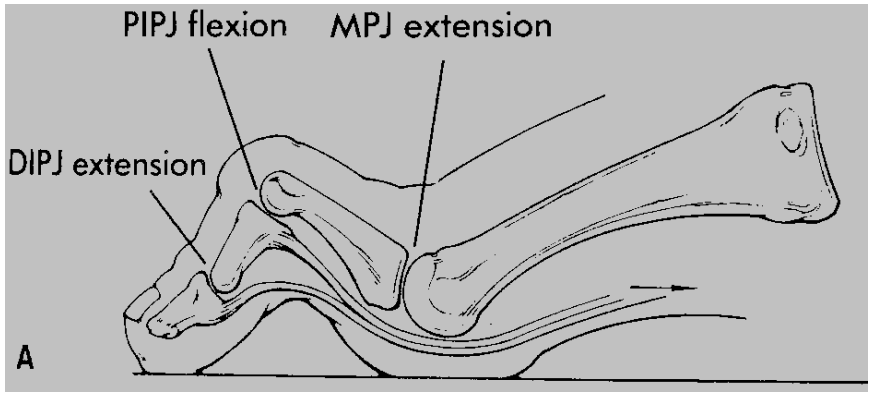
- Non-reducible (Fixed)
  - Joint and/or soft tissue adaptations prevent manual reduction of digit into normal position
- Reducible (Flexible)
  - Digit may be manually reduced into normal position

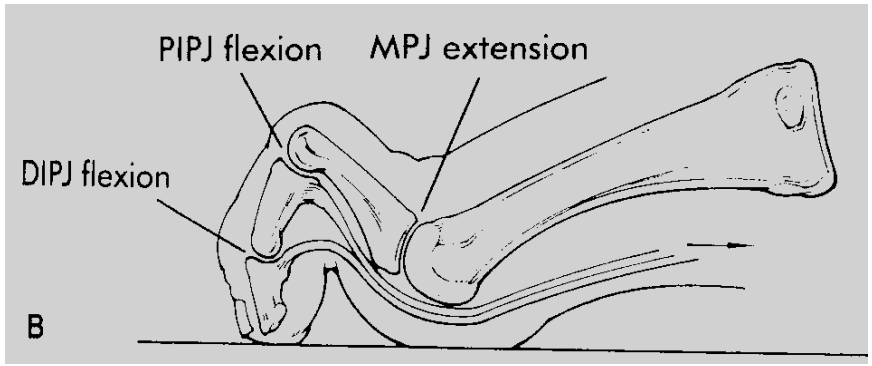
Aetiology

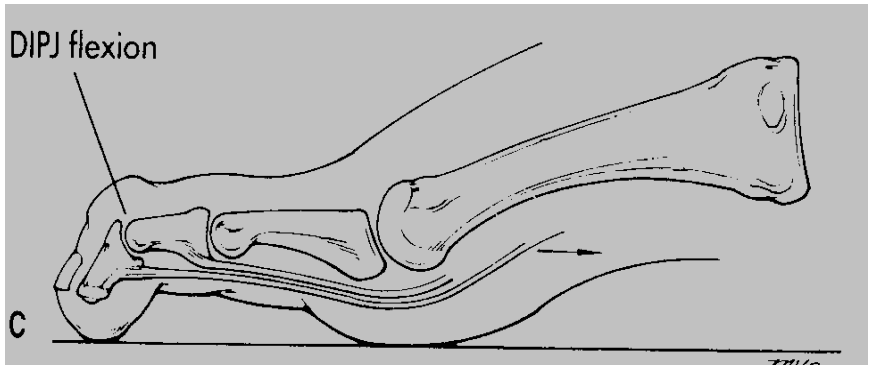
- Congenital
  - Present at birth
    - Intrauterine position
    - Specific birth defect
- Acquired
  - Biomechanical
  - Trauma
  - Secondary to systemic disease process

Digital Deformities

- Sagittal plane
  - Hammer toe
  - Claw toe
  - Mallet toe
- Transverse plane
  - Digitus adductus
  - Digitus abductus
- Frontal Plane
  - Varus toe
  - Valgus toe







Sagittal plane deformities

- **Hammer Toe**
  - Fixed or reducible
  - MPJ extended
  - PIPJ flexed
  - DIPJ either normal, extended or flexed
- **Claw Toe**
  - Reducible
  - MPJ extended
  - PIPJ flexed
  - DIPJ flexed
- **Mallet Toe**
  - Fixed or reducible
  - DIPJ flexed

Associated Skin Lesions

- Heloma durum
- Heloma molle
- Onychoclavis

http://www.foottalk.com/popups/images/disthd.jpg

Digital formulae

Usually 1>2>3>4>5

Or

1=2>3>4>5

Excessively long digit will often contract over time to ‘even-out’ the digital formulae

Anatomy of Lesser Digits

Richie, D. Pathomechanics of Common Foot Disorders , Springer International Publishing 2021

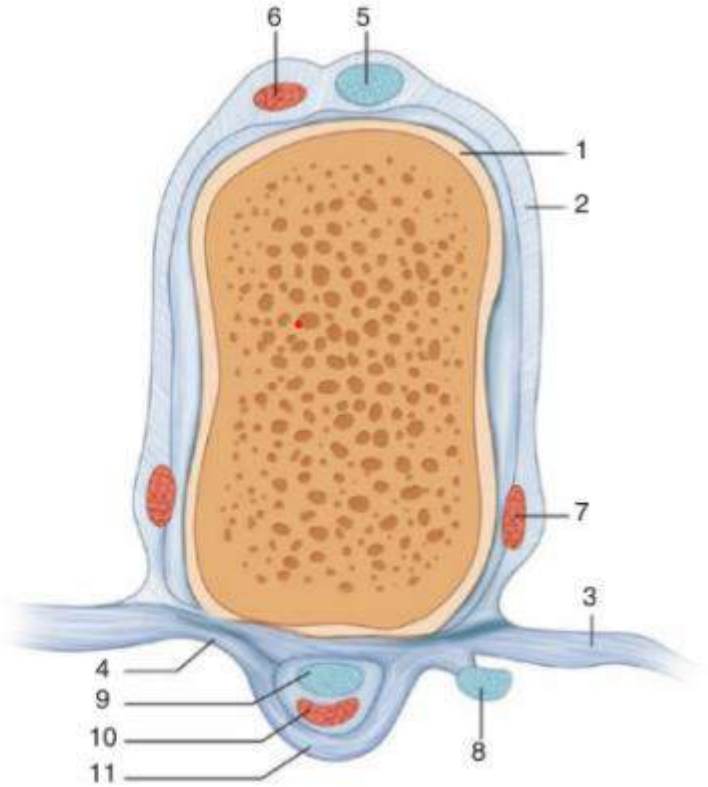
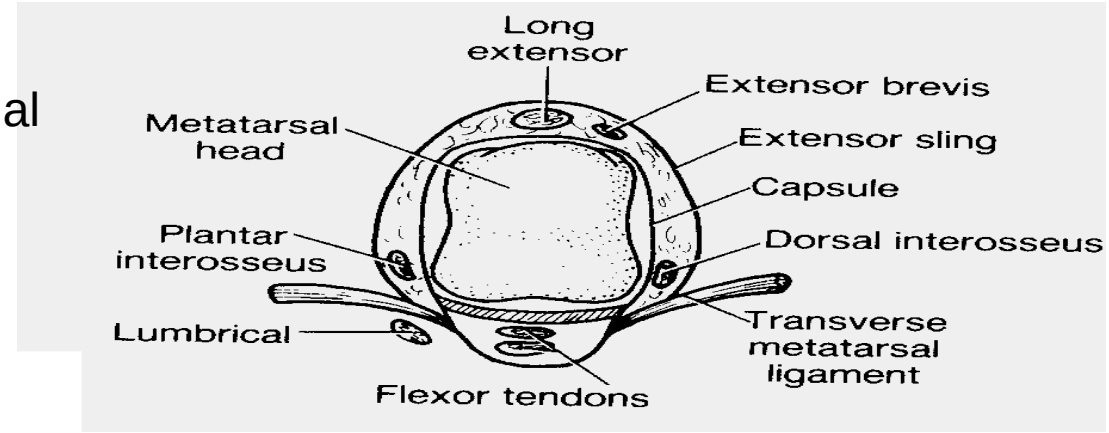


Fig. 6.10 The plantar plate: coronal view. (Reprinted by permission from Springer Nature: Springer, *Hammertoes* by Emily Cook and Jeremy Cook (Eds.) © 2019)
1 = joint capsule, 2 = extensor expansion, 3 = deep transverse metatarsal ligament, 4 = plantar plate, 5 = EDL, 6 = EDB, 7 = interossei within extensor sling, 8 = lumbrical with connection to the plantar plate, 9 = FDL, 10 = FDB, 11 = flexor tendon sheath

Metatarsophalangeal Joint

Medial

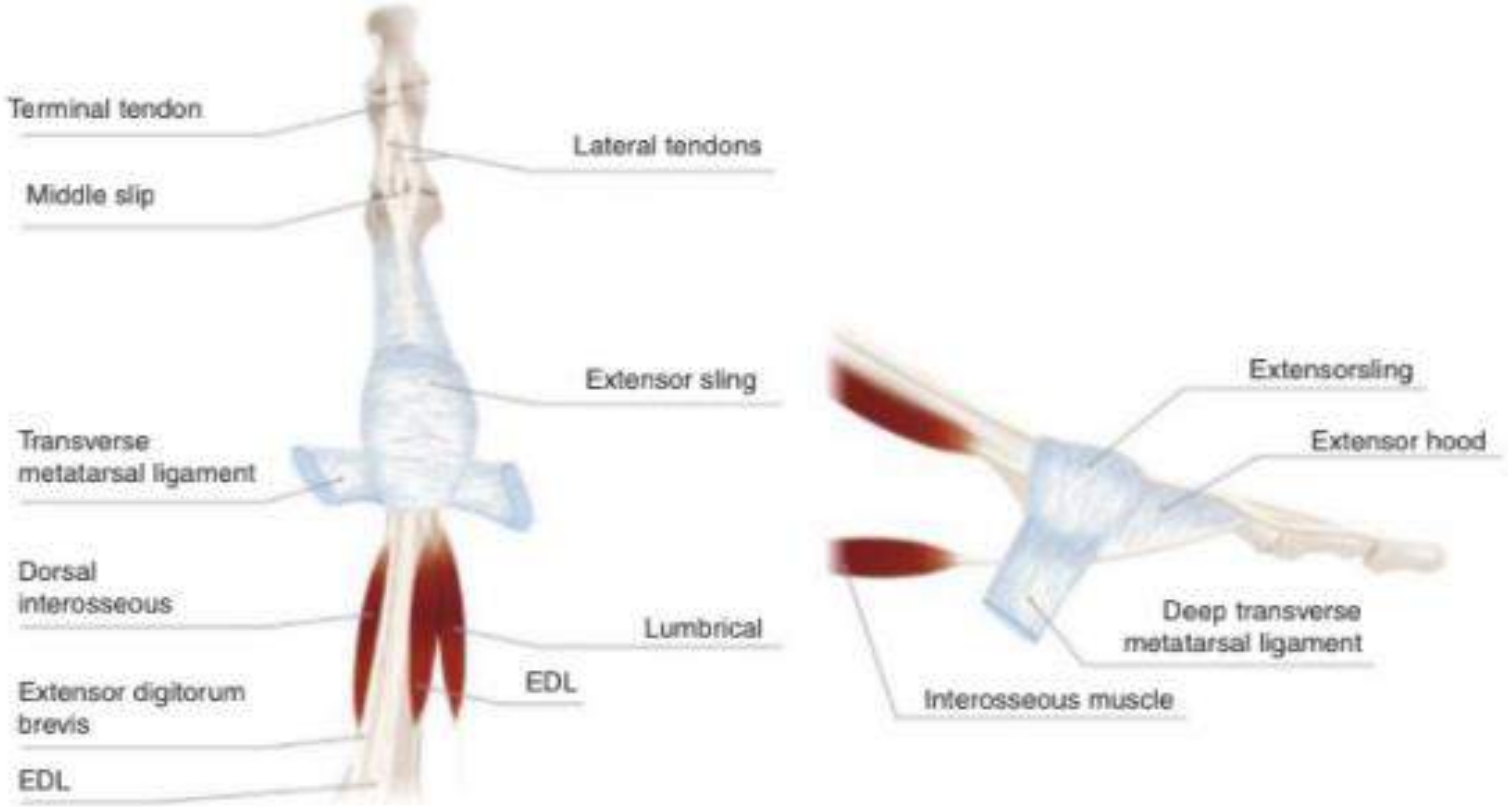


Lateral

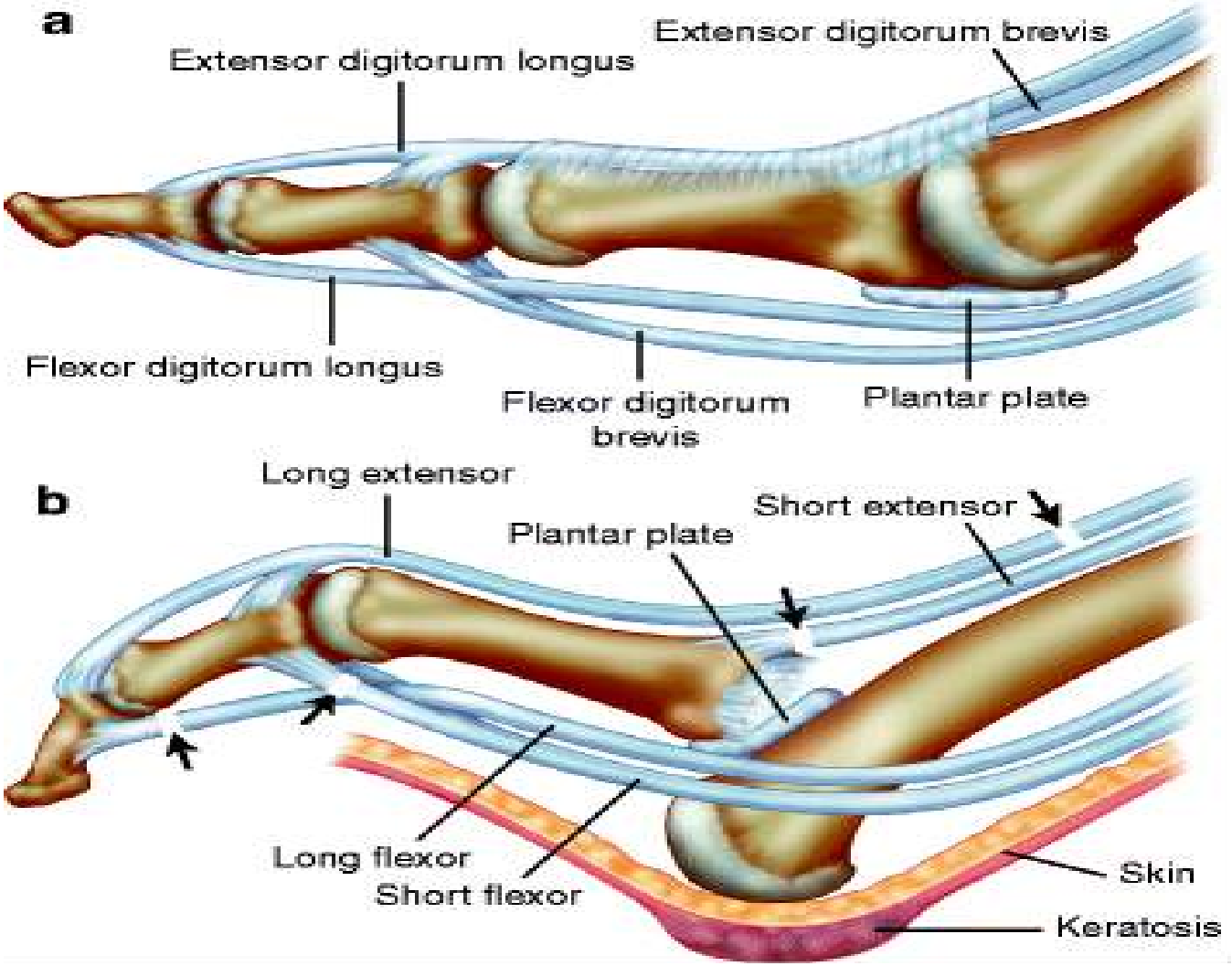
Banks, et al (2004)

- Extensor hood/sling encircle MPJ and unites with fibers of plantar capsule, deep transverse ligament and flexor sheath

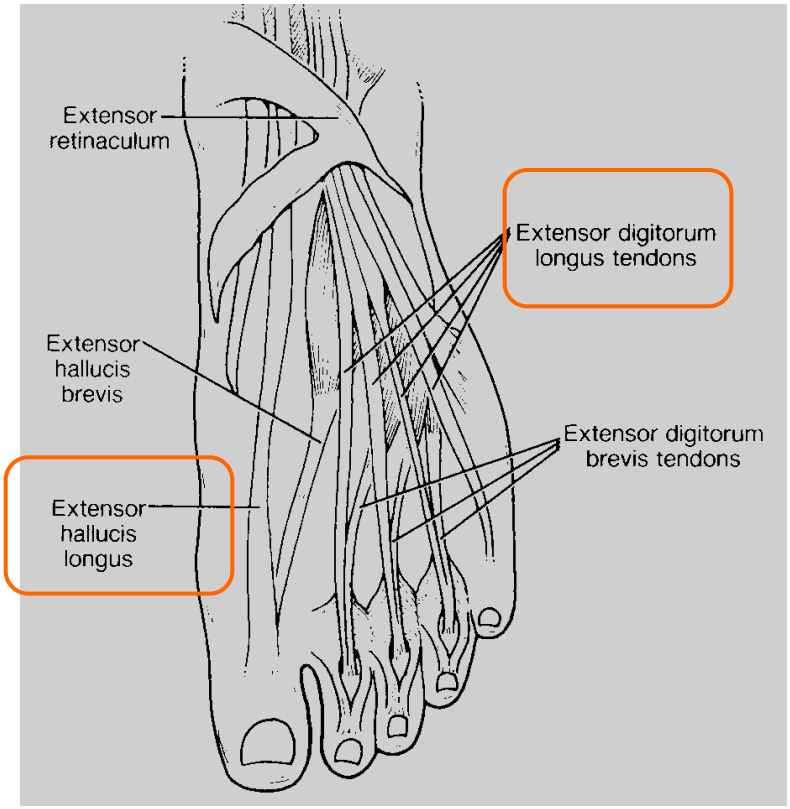
Extensor hood (or sling)



Flexor Tendons Anatomy



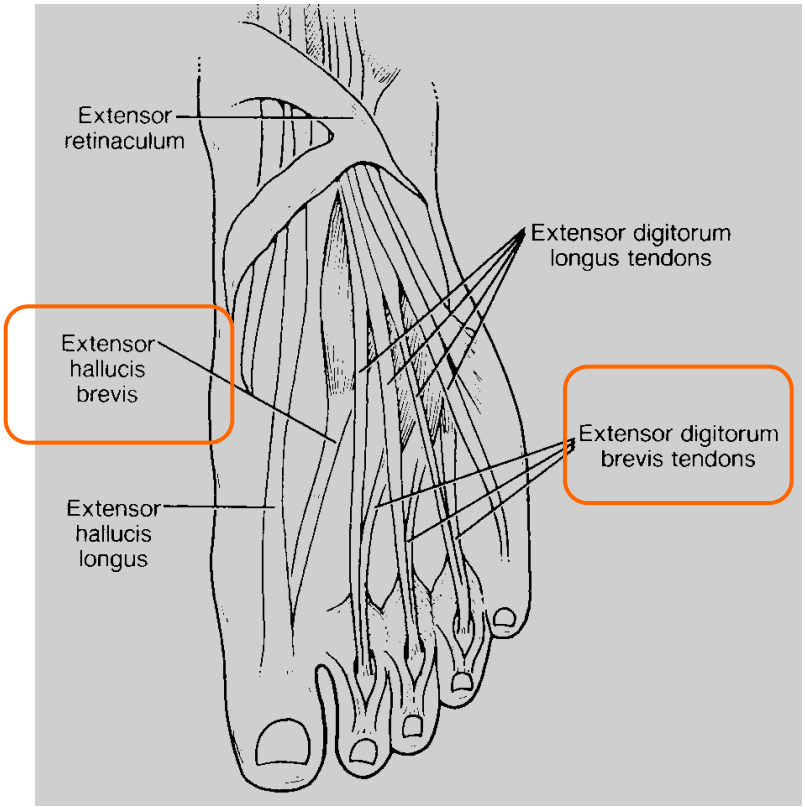
Extensor digitorum longus and extensor hallucis longus



Banks, et al (2004)

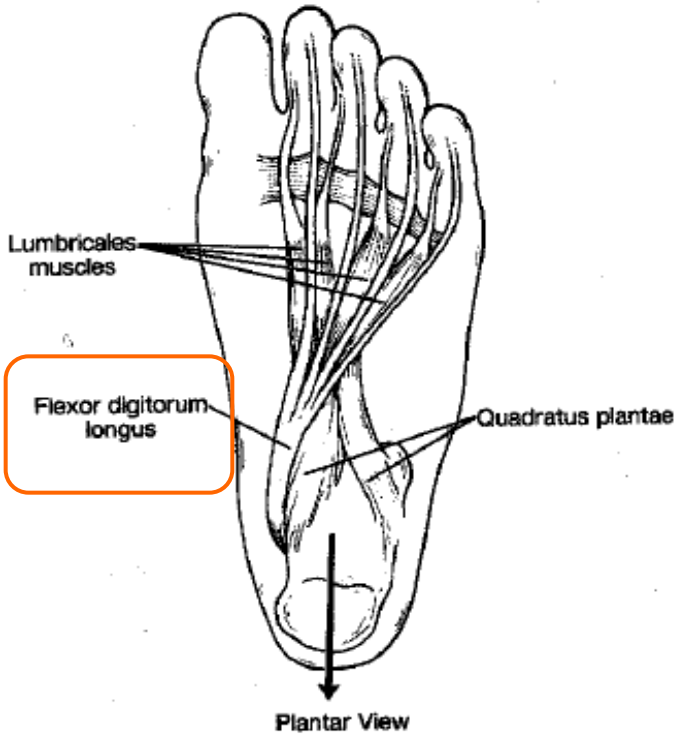
- EDL & EHL arise from anterior compartment of leg
- Pass under extensor retinaculum
- EDL splits into 4 slips and inserts into head middle of phalanx and base distal phalanx
- EHL inserts into base distal phalanx
- Actions:
  - Strong extensors of the MPJ but a weak extensor of the PIPJ and DIPJ
  - Dorsiflexion of foot at ankle

Extensor digitorum brevis and extensor hallucis brevis



- EDB & EHB arise from superior surface of anterior calcaneus
- EDB inserts into base middle phalanx and EDL tendon, approaching the toe from the lateral aspect
- EHB inserts into base proximal phalanx halux
- Actions:
  - Extend toes

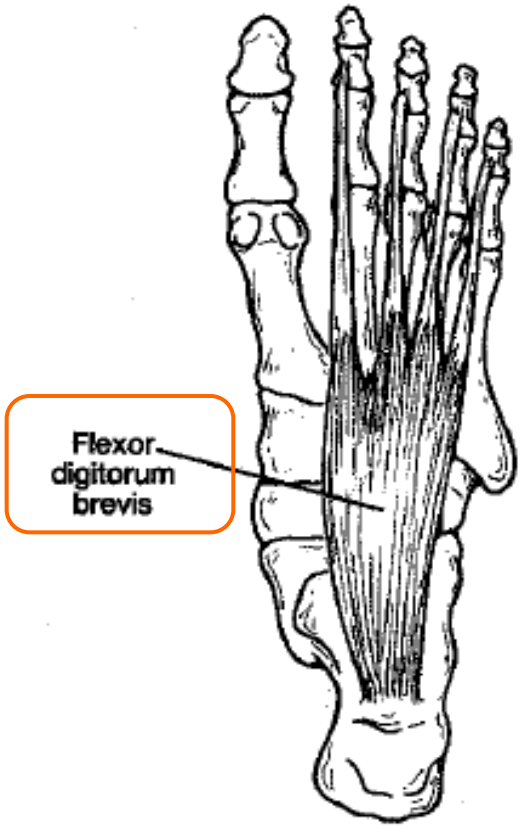
Flexor digitorum longus



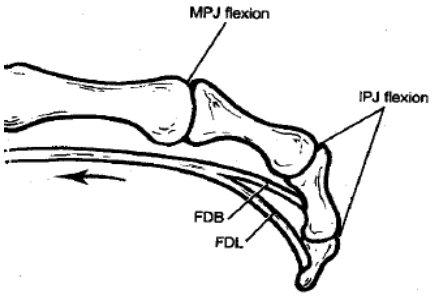
Banks, et al (2004)

- FDL arises from deep posterior compartment of leg, tendon passes behind medial malleolus, under sustentaculum tali & flexor retinaculum splitting into 4 slips to each toe
  - Action: plantarflexes the foot at the ankle and toes at the MPJ and both IPJ

Flexor digitorum brevis

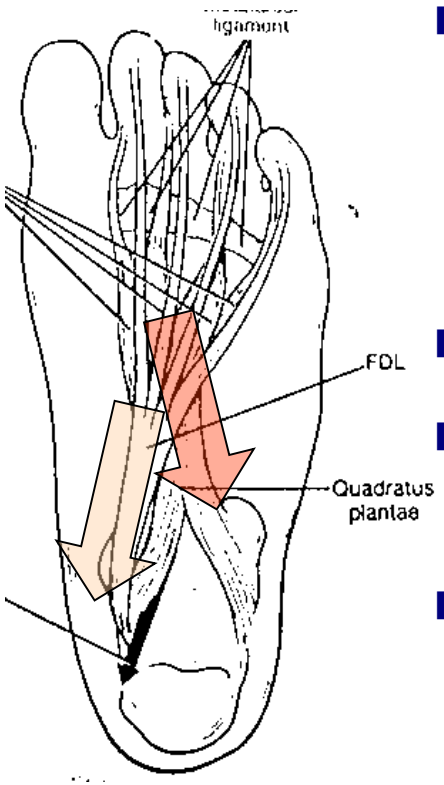


- FDB arises deep to the plantar fascia from the plantar-medial aspect of the calcaneus and inserts into plantar aspect of middle phalanx lesser toes
  - Action: Plantar flexes toes at MPJ and proximal IPJ



Banks, et al (2004)

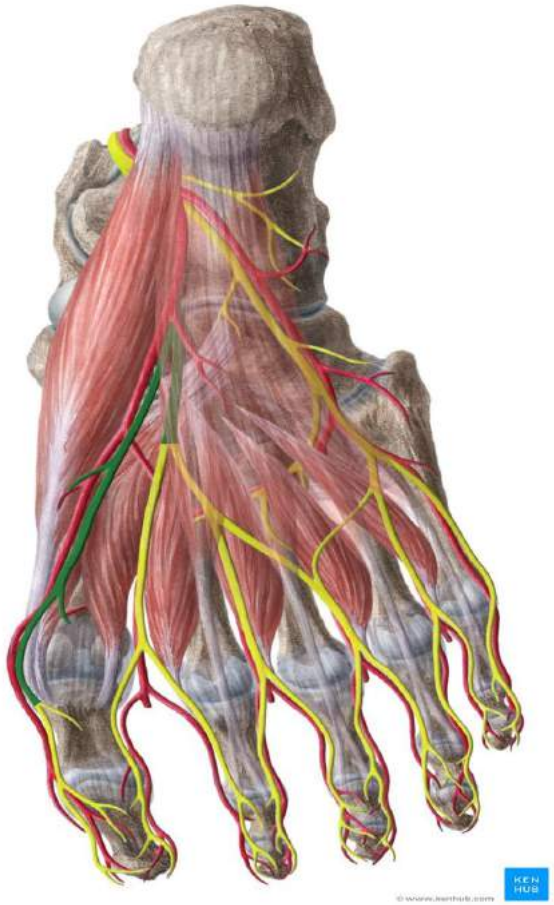
Quadratus Plantae



- Quadratus plantae originates from the inferior calcaneus and inserts into the lateral aspect of the tendon of FDL at the level of division into its four slips
- It stabilises the pull of FDL
- The direction of pull to the 2nd toe is straight and more oblique at the 5th toe
- If quadratus plantae loses it mechanical advantage FDL produces a medial/proximal pull resulting in an adducto-varus pull on the 4th & 5th toes

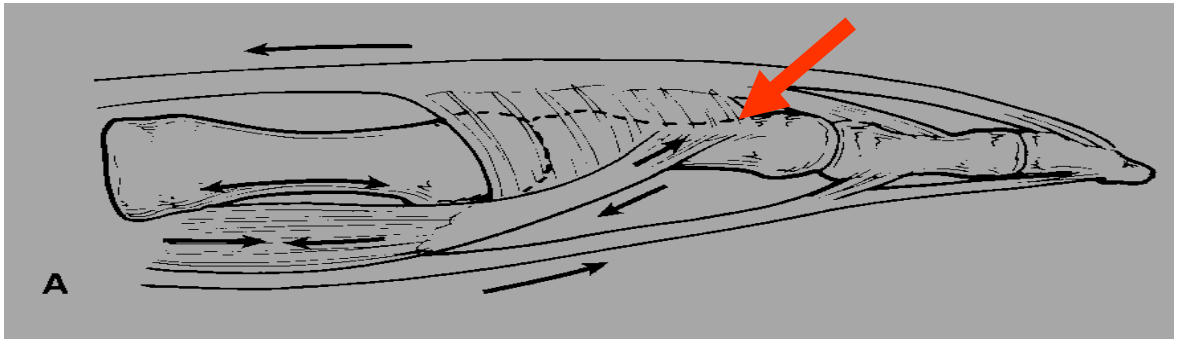
Banks, et al (2004)

Lumbricals plantar & dorsal interossei



PAD DAB

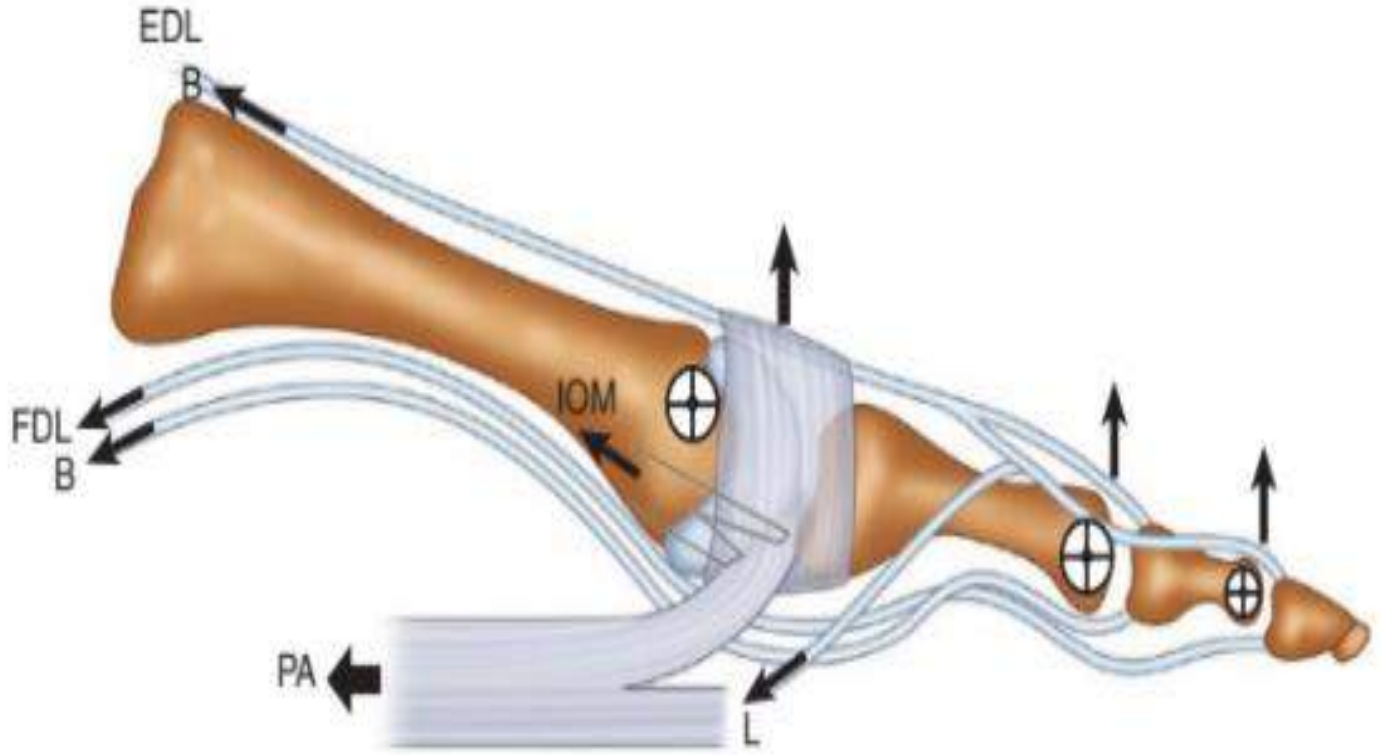
Lumbricals



Banks, et al (2004)

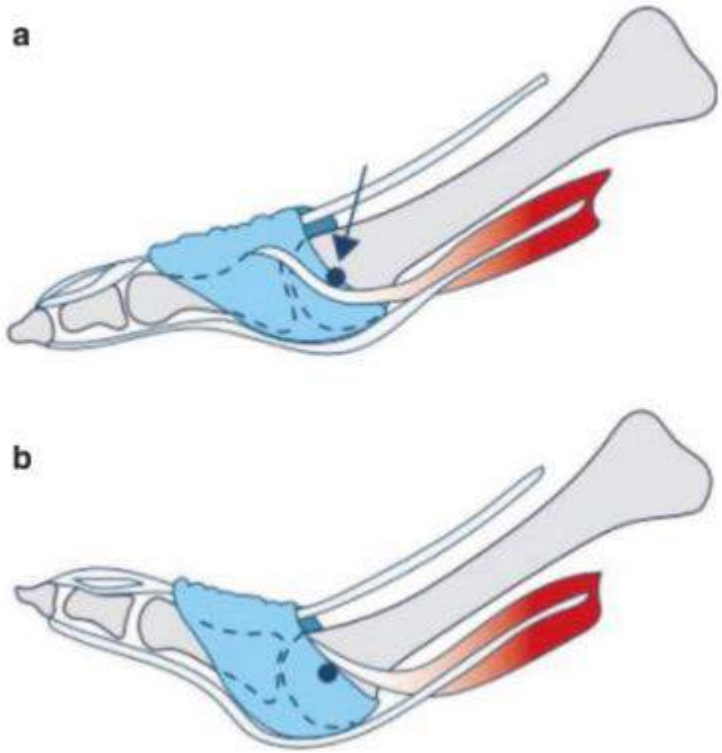
- The lumbricals arise from the tendon slips of FDL and insert into the medial side of the lesser digits through the extensor expansion
  - Action:
  - Weak plantarflexors of the proximal phalanx at the MPJ

The Straight Lesser Digit



a. Neutral MPJ

b. Hyperextended MPJ



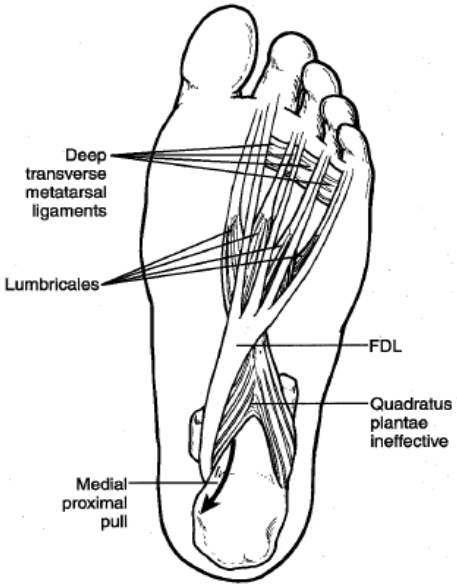
Causes of digital deformity

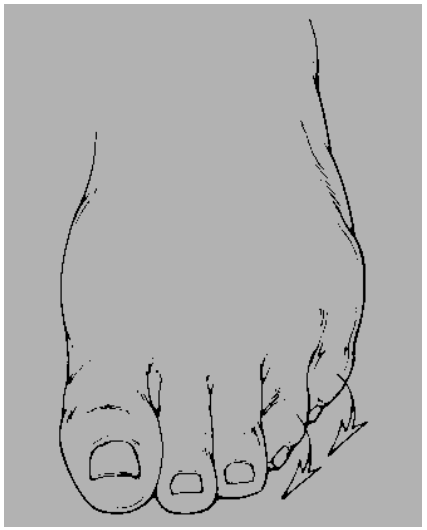
- Muscular balance disrupted due to
  - Biomechanical
    - Greatest cause of lesser digit deformities
    - Structural foot type – pes cavus, pes valgus
  - Neuro/muscular
    - Charcot-Marie-Tooth, Polio, CP, CVA, head trauma
    - Diabetic neuropathy
  - Trauma to forefoot

Categories of pathomechanical causes of lesser hammer toe syndrome

1. Flexor stabilisation
2. Flexor substitution
3. Extensor substitution

1. Flexor stabilisation

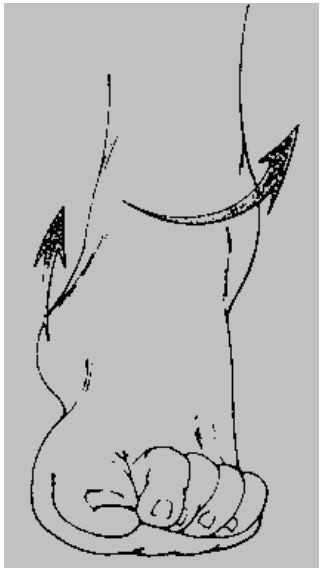


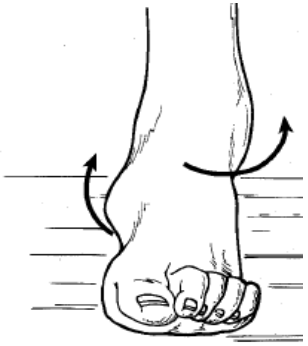


Banks, et al (2004)

- In a **pronated foot** flexors fire earlier and longer in late stance phase in attempt to *stabilise the forefoot*
- FDL and FDB gain mechanical advantage over the interossei
- Quadratus plantae fatigues resulting in an adductovarus 4th and 5th toe deformity

2. Flexor substitution

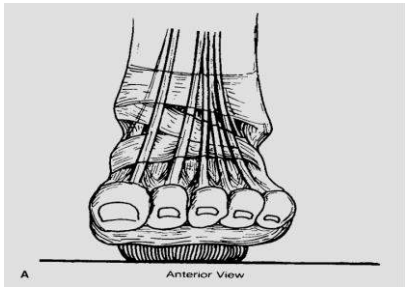


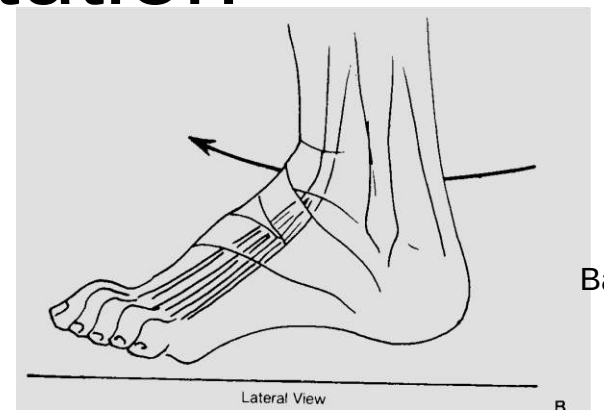


Banks, et al (2004)

- In a **supinated foot** in late stance phase of gait digital flexors try to *substitute* for a weak triceps surae and overpower the interossei
- Usually see a straight contracture of lesser toes
- Least common biomechanical cause of digital deformity
- Often seen with neuromuscular problems which cause calf weakness

3. Extensor substitution

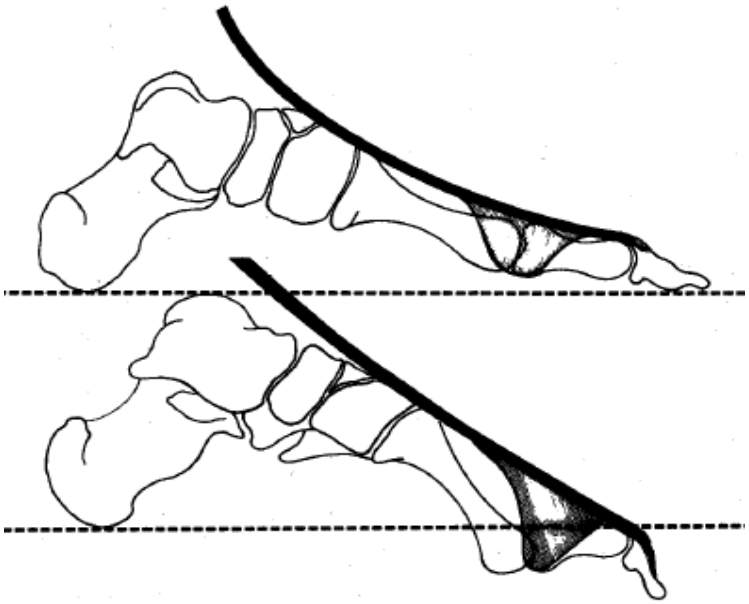




Banks, et al (2004)

- **EDL substitutes for weakness of TibAnt** (primary ankle joint dorsiflexor) during swing phase and heel contact overpowers the lumbricals
  - Ankle equinus
  - Anterior pes cavus
- All lesser toes are contracted

Pes cavus foot type

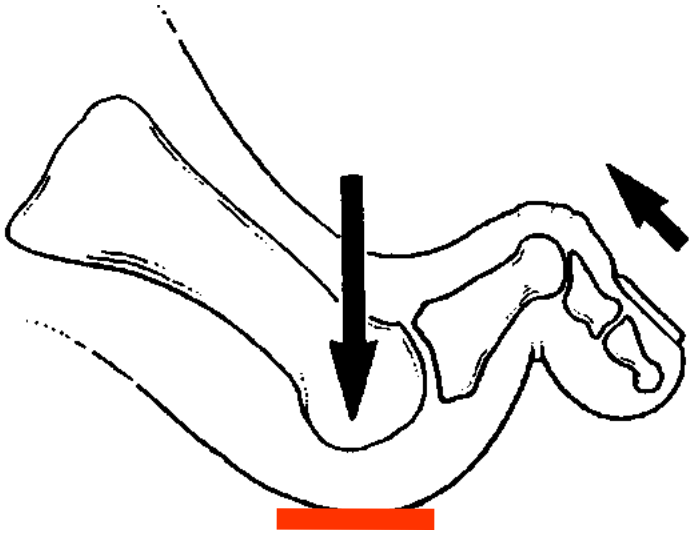


Banks, et al (2004)

- Normal foot
- Pes cavus
  - Increased declination of all metatarsals
  - Adaptive contracture of extensor tendons with associated dorsiflexion of MPJs

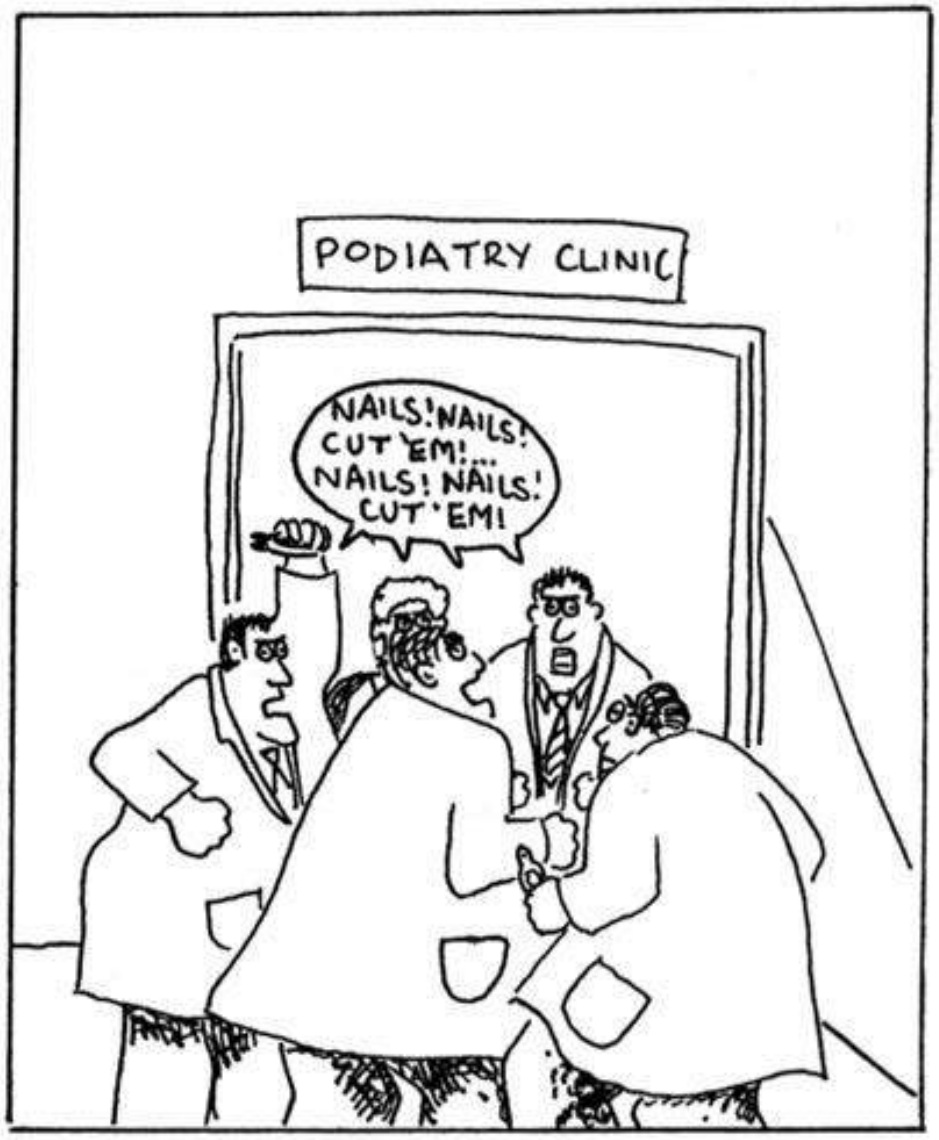
Loss of MPJ Stability & Retrograde Buckling

- Hammer and Claw toe
- Increases load on met head
- Plantar capsulitis/bursitis/IPK



Banks, et al (2004)

Conservative management



Before starting their day, podiatry students must first pump themselves up.

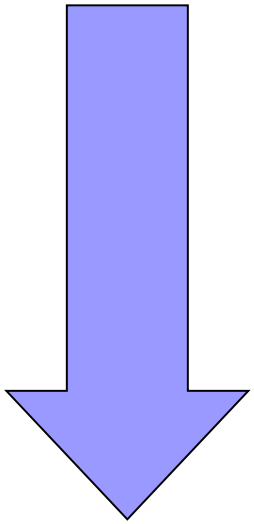
Conservative management

- Reducible deformities
  - Custom silicone devices
  - Commercially available devices
  - Stretching digital tendons
- Non-reducible
  - Treat associated skin lesions
  - Protective padding or digital devices

Digital Deformities

- Sagittal plane
- Frontal plane
- Transverse plane

Correction

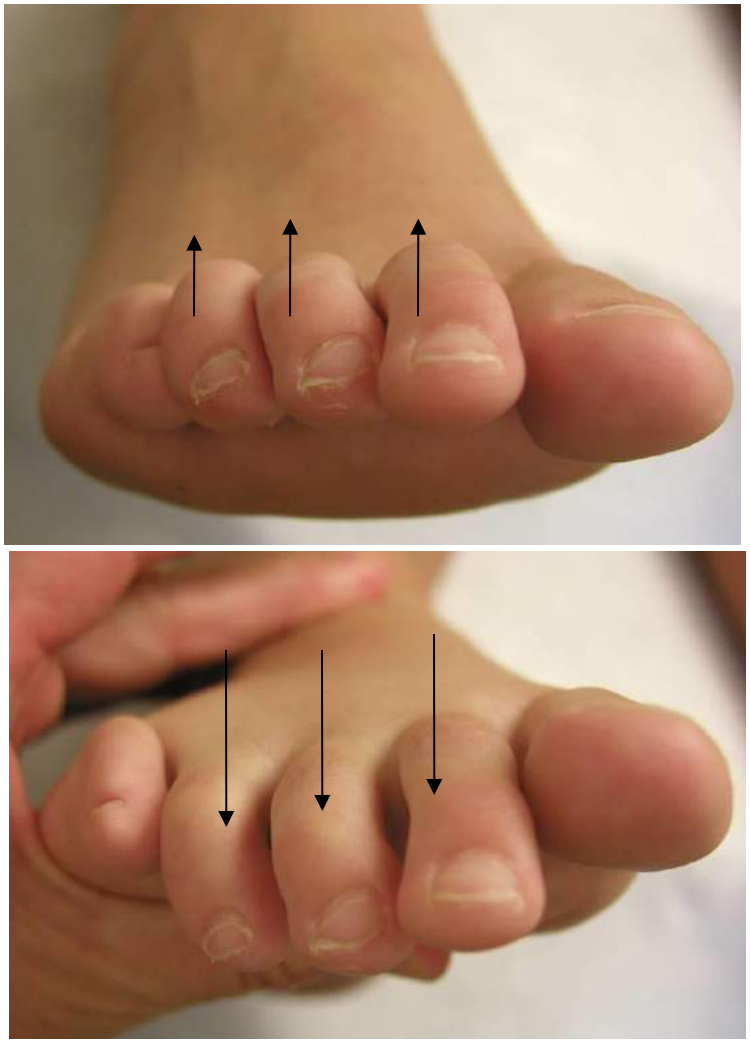


Least difficult

Most difficult

Hammertoe Procedure Assessment

- MPJ reducibility
- NWB vs loaded
- Hyperkeratosis Location
- Adjacent digit
- Ulceration
- HEALTH STATUS



Kelikian push-up test

Health Status

- Neuro-Vasc (optimum toe pressure 70mmHg)
- HbA1c-Optimum below 7%
- Inflammatory arthropathies
- Autoimmune disease/vasculitis
- Coagulation –INR below 1.2-NOACS
- Infection

Soft tissue procedures

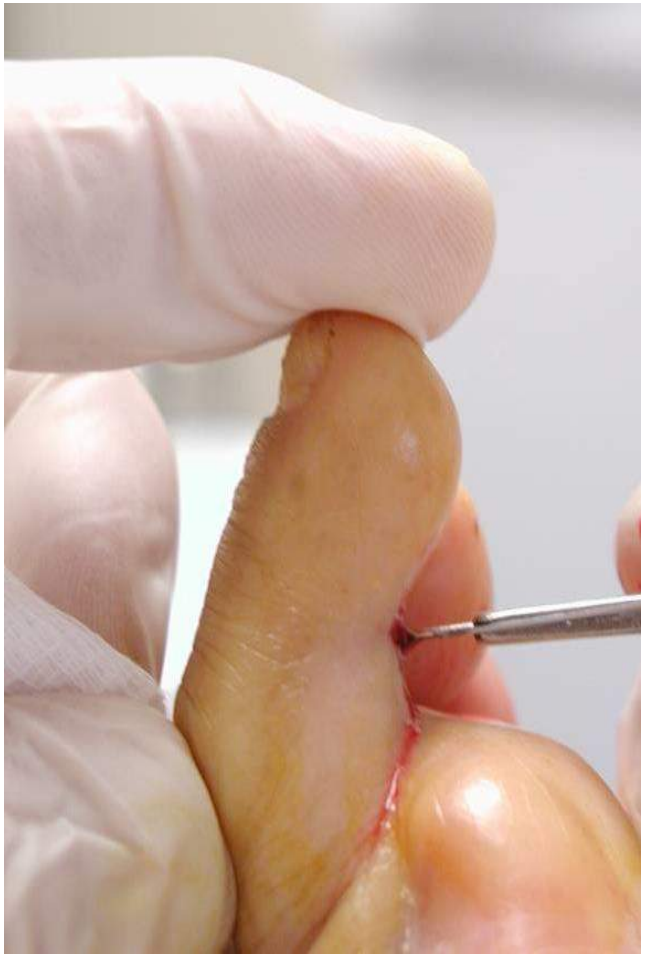
- Indications:
  - Reducible/flexible deformity
- Tenotomy
  - Extensor - isolated procedure in elderly only
  - Flexor – no age restriction
- Capsulotomy
  - For release of tight MPJ capsule
- Syndactylisation
  - Usual for interdigital lesion deep in toe web between 4^{th} and 5^{th} toes

Digital tenotomy - indications

- Manually reducible toe deformity
- Flexor contracture dominant feature
  - Mallet toe
  - Claw toe
  - Adducto-varus claw toe
  - +/- Callus/ulcer

Flexor tenotomy - benefits

- Simple
- Low risk
- Office based procedure
- Avoids bone surgery
- Safe in adequately selected 'high-risk' patients
- Minimal complications
- POTENTIAL TO PREVENT AMPUTATION



Indications For Flexor Tenotomies in Diabetic Toe Ulcers

- Tip-toe or apical ulcer-Most common
- Dorsal ulcers PIPJ/DIPJ-FDL/EDL release
- Kissing ulcers-FDL/EDL release
- Plantar metatarsal head ulcers-FDL/EDL release

Percutaneous Tenotomy for the Treatment of Diabetic Toe Ulcers

Foot & Ankle International
2014, Vol 35(1) 38–43

DOI: 10.1177/1071100713509604
fai.sagepub.com

Eran Tamir, MD[1,2,3], Mordechai Vigler, MD[3,4], Erez Avisar, MD[1,2], and Aharon S. Finestone, MD, MHA[1,2,3]

Abstract

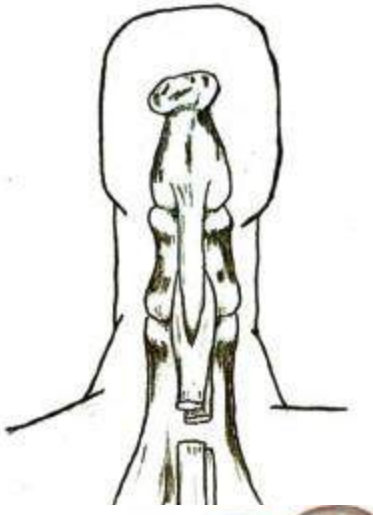
Background: Foot ulcers have been implicated as a causative factor in diabetic foot amputations. The purpose of this study was to evaluate treating foot ulcers in patients with diabetes by percutaneous tenotomy.

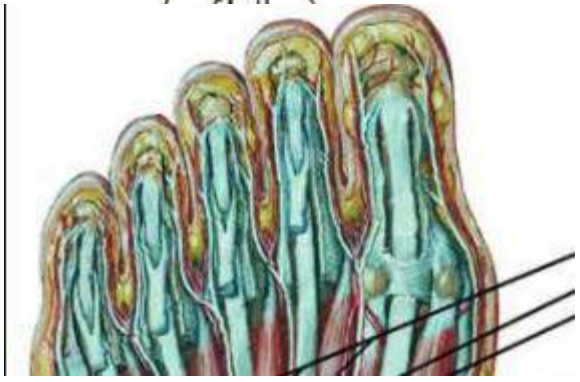
Methods: We retrospectively reviewed the computerized medical files of 83 patients treated for foot ulcers by percutaneous tenotomies. Results were analyzed on the basis of indication and per patient.

Results: The 83 patients had 160 tenotomies for 4 indications: 103 tip-of-toe ulcers (treated by flexor digitorum longus tenotomy), 26 cock-up/dorsal ulcers (extensor digitorum longus tenotomy), 21 kissing ulcers (extensor digitorum longus and/or flexor digitorum longus tenotomies), and 10 plantar metatarsal ulcers (extensor digitorum longus with or without flexor digitorum longus tenotomy). Healing at 4 weeks was 98%, 96%, 81%, and 0%, respectively. The complication rate was very low, with the exception of "transfer lesions," where an adjacent toe became involved and needed subsequent tenotomy in 8% of tip-of-toe ulcers.

Conclusions: Percutaneous tenotomy was an effective and safe method for treating toe ulcers in neuropathic patients. It was not effective in treating plantar metatarsal ulcers.

Flexor tenotomy-Anatomy FDB and FDL





Complications

- Failure to correct deformity

Non reducible deformity

Failure to understand the pathomechanics of the hammertoe (Flexor stabilization)

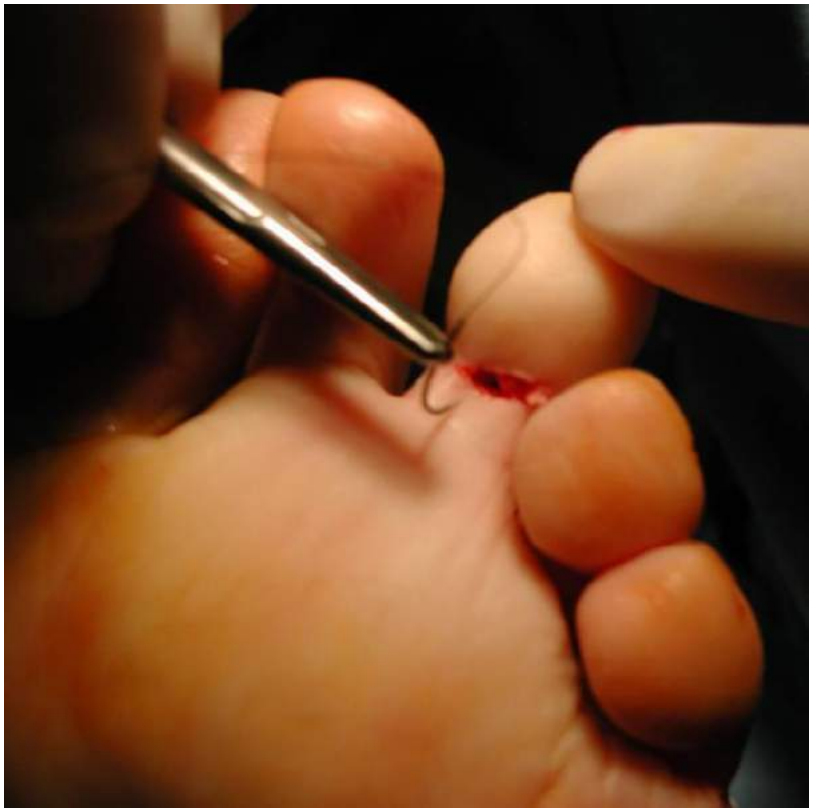
Patient may need arthroplasty and arthrodesis

- Failure to resolve painful callus or ulcer
- Overcorrection (hyperextension deformity)
- Infection/numbness/scarring (0-2.8%)
- Transfer loading (0-17%)
- Balance problem
- Reactivation of Charcot

Traditional technique - using # 15 scalpel or # 67 Beaver blade

Ring block

Plantar stab-



Maintain initial correction with Steristrip™

Dress with sterile gauze and Coban

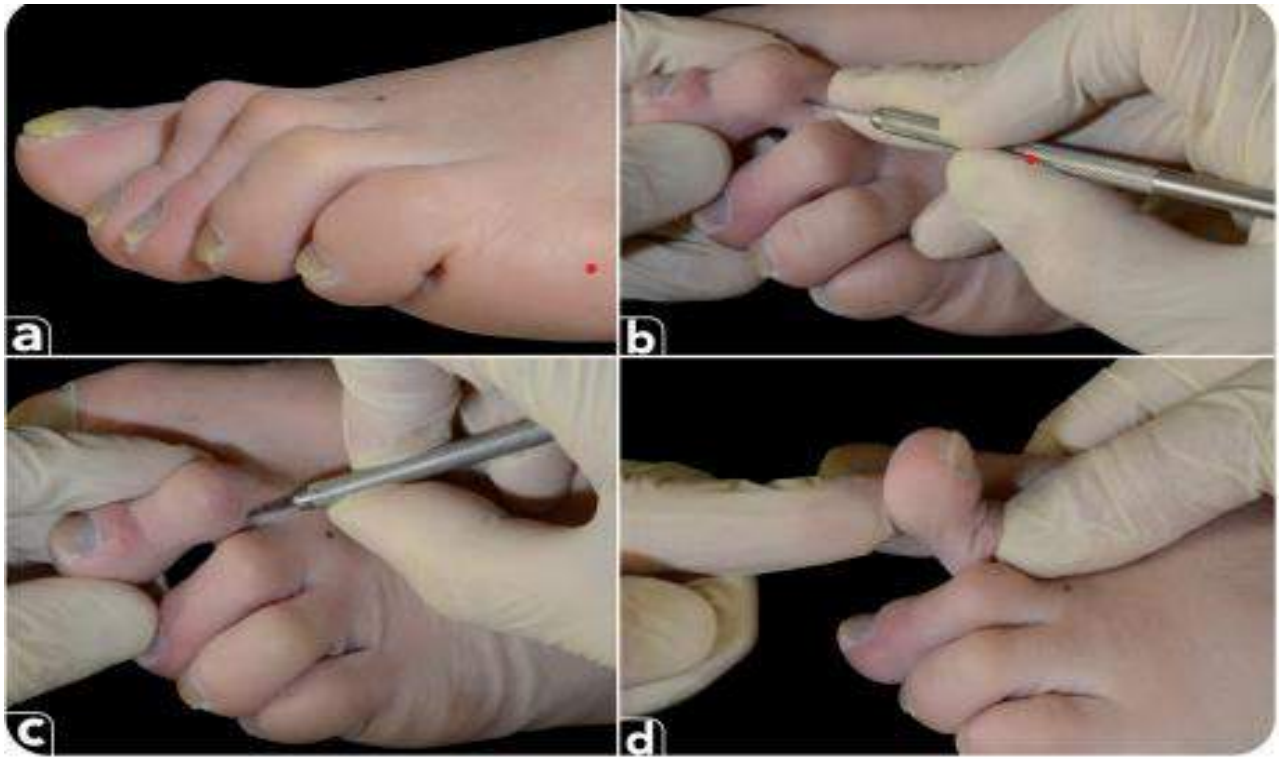
Follow with Coban only for 4-8/52 to maintain correctio

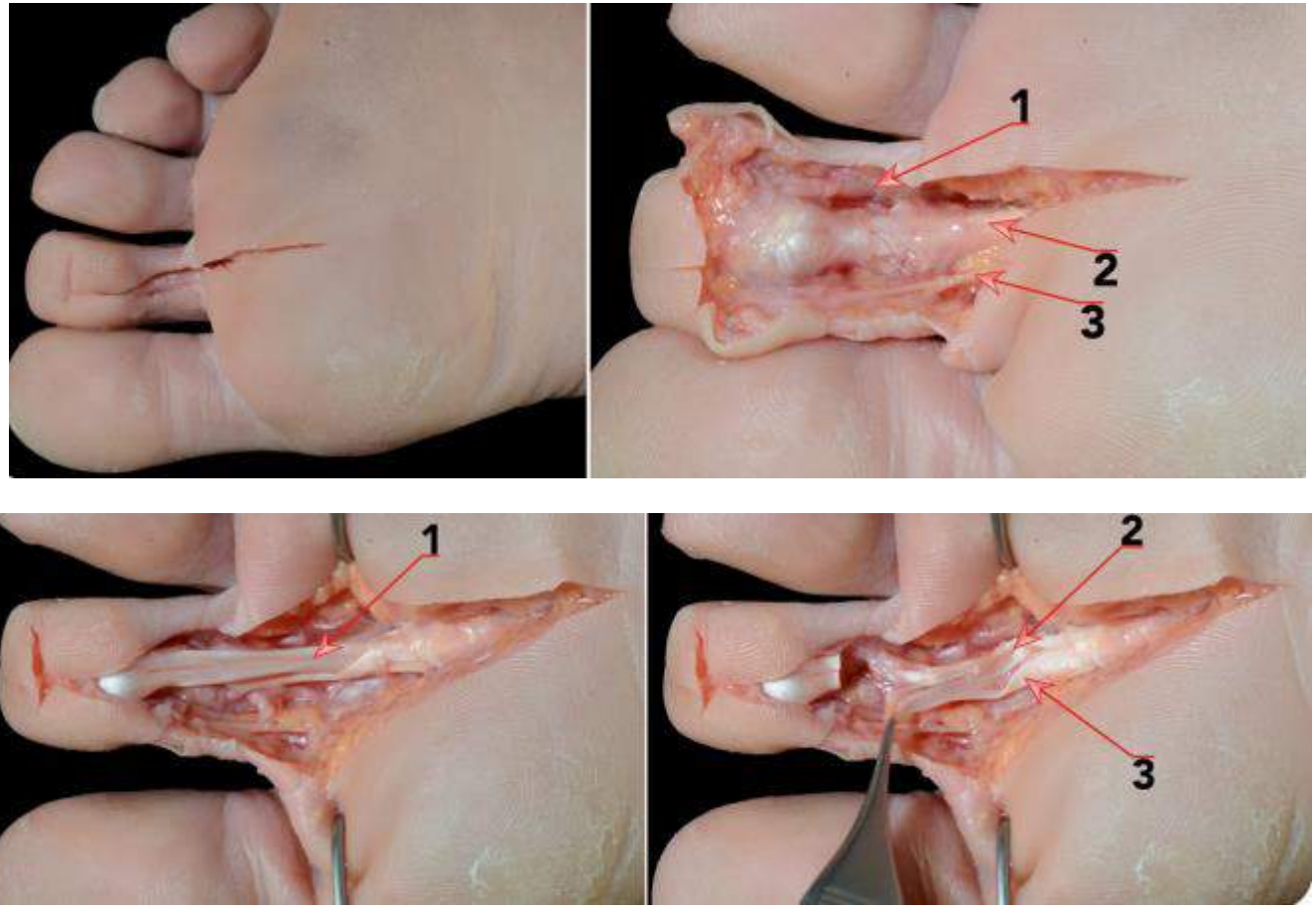
* Care with insens toes

Dress with Gelatamp™ rather than suture to allow for skin lengthening via secondary healing

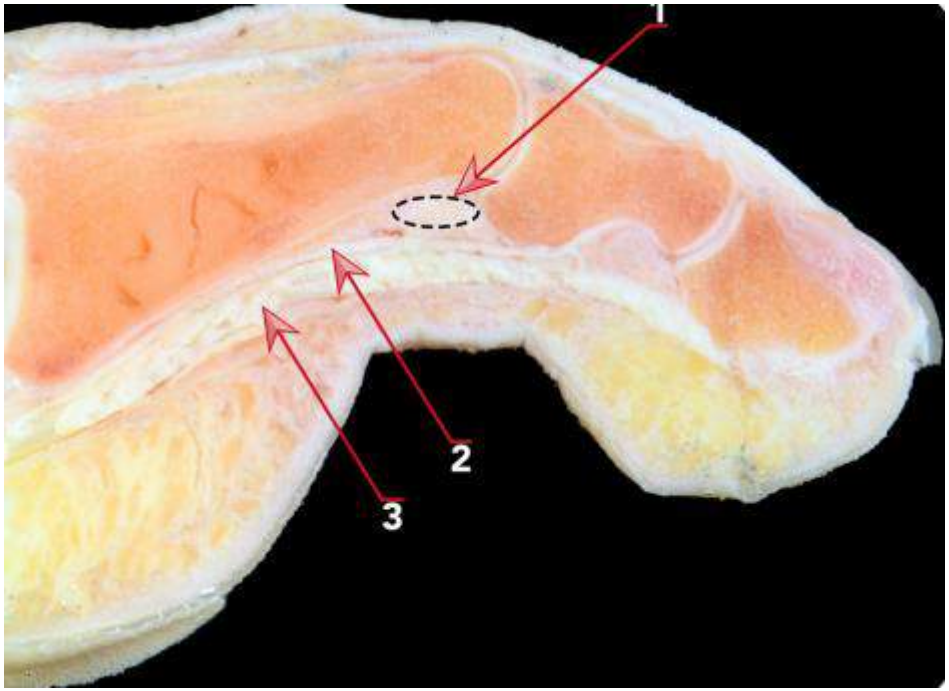
Stepwise Flexor Tenotomy/ De Prado Technique

Carvalho, Paulo et al, 'Percutaneous Flexor Digitorum Brevis Tenotomy: An Anatomical Study' [2021] Foot and ankle surgery

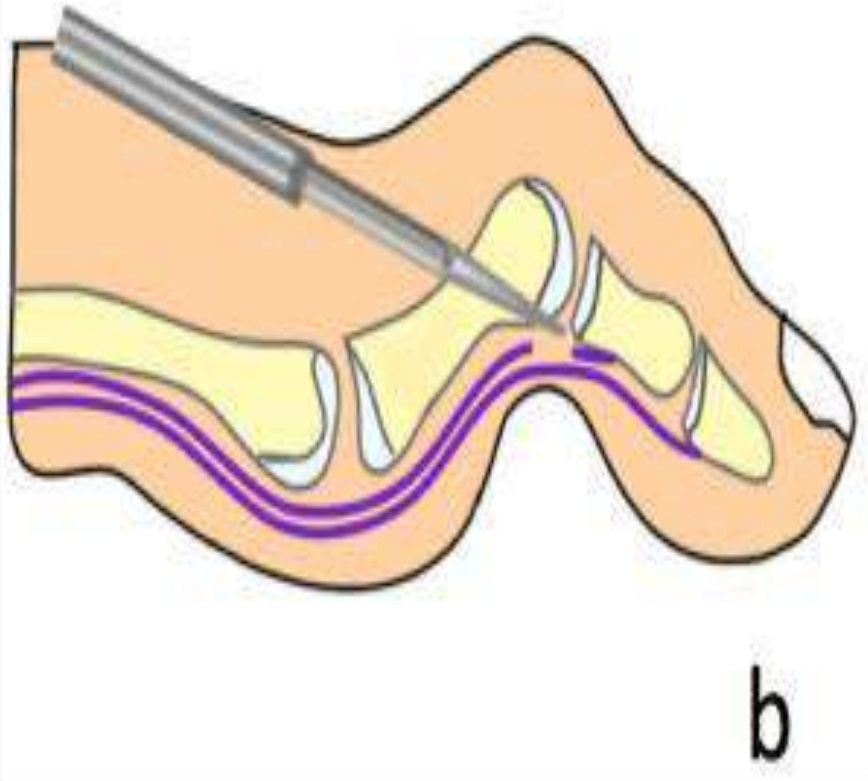



1
2
3
1
2
3

Carvalho et al 2021
Performing PIPJ arthrolysis and FDB tenotomy



FDB Release only!
Does it work in intrinsic minus foot



Impact of intertendinous connections between the flexor digitorum brevis and longus on percutaneous tenotomy for the treatment of claw toes: an anatomic and ultrasound study

Julien Beldame[1] · Matthieu Lalevée[2] · Sixtine Regnard[2] · Florent Marguet[2] · Marie Csanyi-Bastien[2] · Marion Masse[3] · Fabrice Duparc[2,4]

Received: 22 December 2020 / Accepted: 20 February 2021

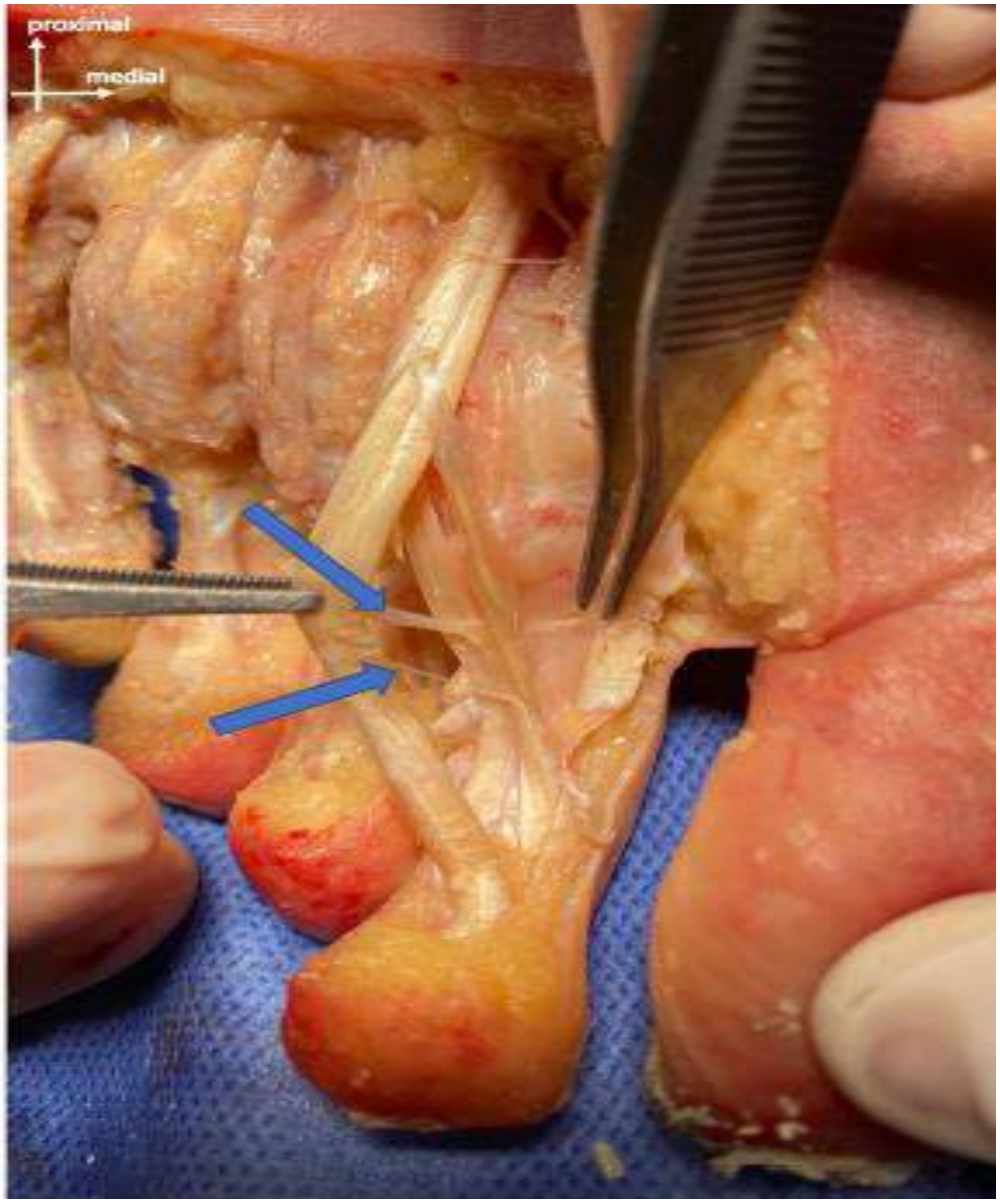
Abstract

Purpose Selective percutaneous tenotomy of the flexor digitorum longus (FDL) is a treatment for claw toes that gives astonishingly good functional results despite tendon sacrifice. However, the involution of the FDL tendon stump after tenotomy is unknown. The aim of our study was to assess the involution of the tendon stump after selective percutaneous tenotomy of the FDL.

Methods The study included two parts. In the clinical part, an ultrasound analysis of 15 FDL tenotomies in 7 patients was carried out 3 months post-surgery. In the anatomic part, the feet of 10 bodies donated to science were dissected and examined anatomically.

Results The proximal stump of the FDL was located near the base of the proximal phalanx and moved synchronously with the flexor digitorum brevis (FDB).Separating the FDB and FDL revealed a large tissue connection between the plantar surface of the tendinous chiasm of the FDB and the dorsal part of the FDL. These connections had significant resistance ranging from 2 to 9 Newtons depending on the toe. Tenotomy of the FDL followed by proximal traction of it led to retraction of the stump up to the base of the proximal phalanx and transfer of its action to the FDB by tensioning the intertendinous structure. Histologically, these structures were mostly comprised of tendon connective tissue. Their vascular component was small.

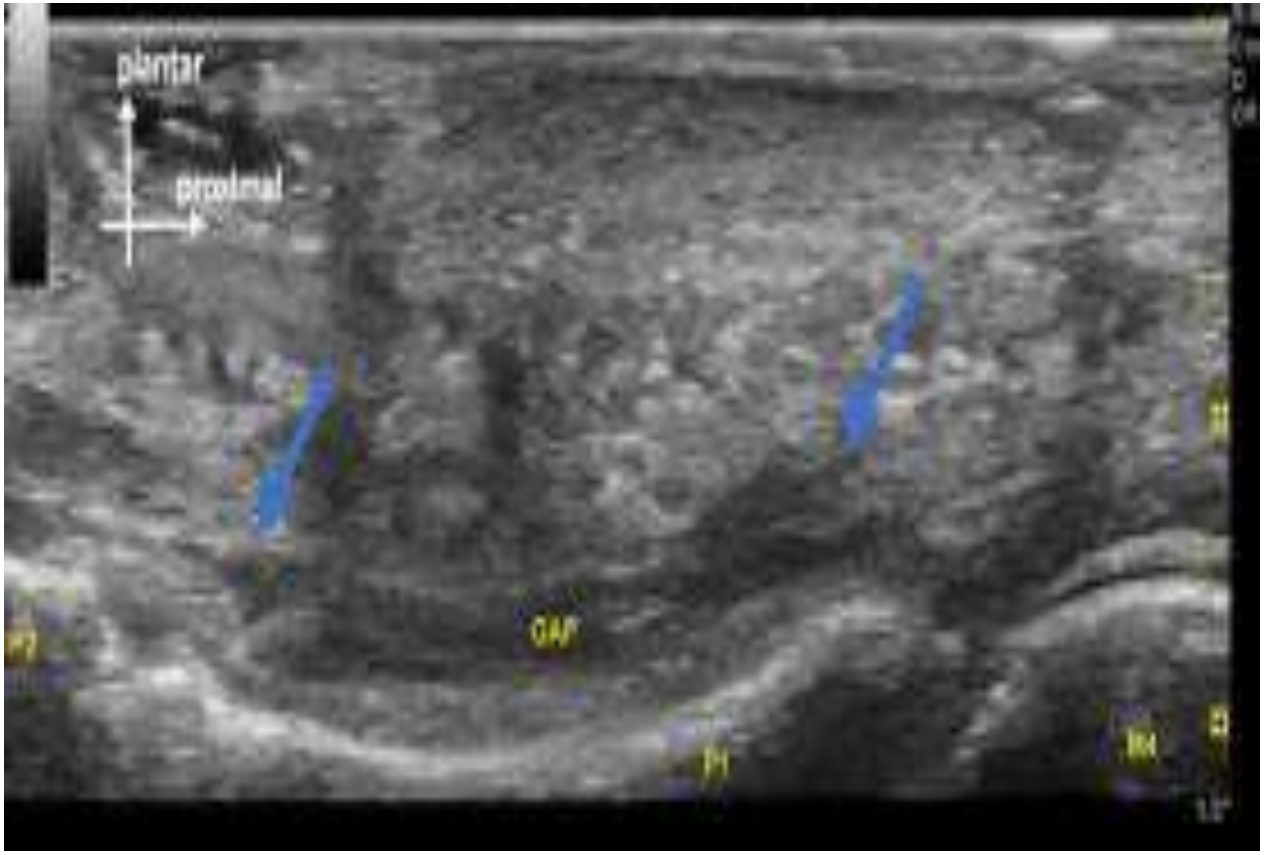
Conclusion The presence of this intertendinous connection leads, in the case of isolated tenotomy of the FDL, to equivalent transfer of the latter to the FDB.


proximal
medial

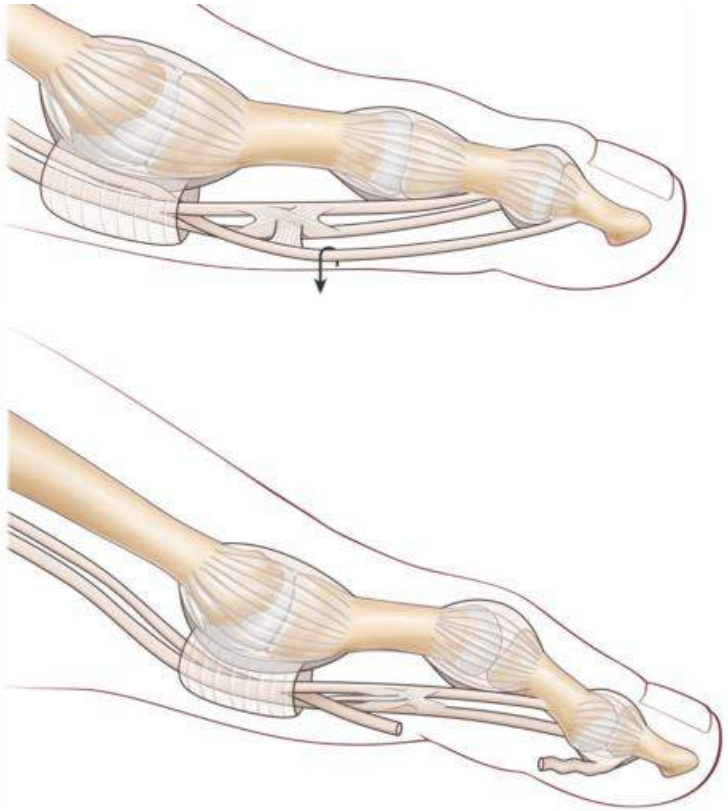

proximal
lateral

Baufo et al 2019

Post FDL Tenotomy



Scheme for the intertendinous connection and for its tightening during tenotomy of the FDL, leading to a tenodesis efect on the FDL (Beldame et al 2021)



Needle technique

Using 18-19g needle

Chesnel, Camille et al, 'Effectiveness and Complications of Percutaneous Needle Tenotomy with a Large Needle for Muscle Contractures: A Cadaver Study' (2015) 10(12) *PloS one* e0143495

Tendons	Tenotomies				Neighboring structures potentially at risk	Lesions
	Complete	Partial	Failure	N		
Tibialis posterior	4	1	1	6	Posteriour tibial arteries and veins	0
					Tibial nerve	0
					Flexor digitoum longus tendon	1
Abductor hallucis	4	3	1	8	Branch of the plantar metatarsal artery	0
					Branch of the medial plantar nerve	0
					Tendon of the medial head of flexor hallucis brevis	0
Toe flexors	93	37	0	130	Proper plantar nerves	2
Tibialis anterior	6	3	0	9	Dorsal artery and vein of the foot	0
					Deep peroneal nerve	0
					Extensor hallucis longus tendon	0
Achilles tendon	8	2	0	10	Peroneal artery and vein	0
					Posterior tibial artery and vein	0
					Tibial nerve	0
					Plantar nerve	0
					Flexor hallucis longus tendon	0
Biceps femoris	7	2	1	10	Common peroneal nerve	0
Semi-tendinosus (ST) et Gracillis (G)	7 (5ST + 2G)	4 (1ST + 3G)	5 (2ST + 3G)	16 (8ST + 8G)	Popliteal artery and vein	0
					Tibial nerve	0
					Sartorius muscle	1
					Tendon of semimembranosus	2
Tensor fascia lata	8	2	0	10	None	0
Total	137	54	8	199	**Vessels**	0
					Nerves	2
					Tendons or muscles	4

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Journal of Clinical & Translational Endocrinology

journal homepage: www.elsevier.com/locate/jcte

The effect of needle tenotomy on hammer, mallet and claw toe deformities in patients with diabetes, a retrospective study

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ARTICLE INFO

Keywords:
Diabetic foot ulcer
Deformities
Tenotomy
Needle
Preventive surgery
Offloading

ABSTRACT

Aim: The aim of this study was to evaluate outcomes of needle tenotomies as a treatment option for hammer, mallet and claw toes in patients with diabetes.

Methods: This was a retrospective study where all patients receiving flexor tendon tenotomy by needle at our outpatient clinic were identified through the electronic patient record system.

Results: A total of 81 patients that had 106 tenotomy procedures performed were identified. The 81 included (68% male) had an average age of 65.4 years, and 27 (33%) had Type 1 diabetes. Of the 106 procedures 36 were performed due to an ulcer on the feet. Of the 36 treated ulcers, 34 (94%) healed in an average time of 28 days. Tenotomies performed to prevent impending ulcers from progressing to active ulcers, were performed 84 times in total. Of the 84 procedures 6 patients progressed to an active ulcer. No serious complications i.e. infections or amputations in relation to the procedure were registered.

Conclusion: Needle flexor tenotomies are a relatively safe and effective treatment compared to tenotomies done by scalpel, both as treatment for ulcers and to prevent formation of new ulcers associated with hammer, mallet and claw toe deformities. As a side note, transfer lesions are avoidable if all toes on one or both feet are tenotomized in one procedure.

Hedegaard Andersen, Jonas et al, 'The Effect of Needle Tenotomy on Hammer, Mallet and Claw Toe Deformities in Patients with Diabetes, a Retrospective Study' (2019) 18 *Journal of clinical & translational endocrinology* 100208

Tenotomy characteristics.

	Total	Patients with ulcers	Patients without ulcers	P-Value*
N	106	36	70	
Number of toes operated	293	62	231	
Offloading procedure of at least one toe	84	14	70	
Progression to active ulcer after preventive procedure of at least one toe per procedure**	6 (7%)	1 (7%)	5(7%)	1.0
Time of ulcer before tenotomy (weeks) (median(Q1-3))	N/A	4.5 (2.0-8.5)	N/A	N/A
Ulcer healed	N/A	34 (94%)	N/A	N/A
Mean time to ulcer healing (days)	N/A	28 ± 35.2	N/A	N/A
Healing of incision	106 (100%)	36 (100%)	70 (100%)	1.0
Mean time to Incision healing (days)	4.4 ± 2.5	4.3 ± 2.5	4.5 ± 2.6	0.36
Ulcer diagnosis	N/A		N/A	N/A
Ischemic		3 (8%)		
Neuropathic		28 (78%)		
Neuro-ischemic		5 (14%)		
Ulcer recurrence	N/A	5*** (15%)	N/A	N/A
Transfer lesions				
Total	25 (24%)	12 (33%)	13 (19%)	0.43
Ulcer	7 (7%)	5 (14%)	2 (3%)	0.17
Impending ulcer	18 (17%)	7 (19%)	11 (16%)	0.79
Minor amputations	3 (3%)	1 (3%)	2 (3%)	1.0
Major amputation	1 (1%)	1 (3%)	0	0.35
Infections	0	0	0	1.0
Re-tenotomi	4 (4%)	1 (3%)	3 (4%)	1.0
Extensor tenotomi	4 (4%)	0	4 (6%)	0.3
Pain	14 (13%)	0	14 (20%)	0.02

Smith, Simon E and Julie Miller, 'The Safety and Effectiveness of the Percutaneous Flexor Tenotomy in Healing Neuropathic Apical Toe Ulcers in the Outpatient Setting' (2020) 13(2) *Foot and ankle specialist* 123

Ulcer and Toe Characteristics	
Ulcer frequency, n (%)	
Total	11
Digit 2	8 (72.8)
Digit 3	3 (17.2)
Ulcer duration (days)	
Range	7–728
Mean ± SD	147.6 ± 204.2
History of infection (requiring antibiotics), n (%)	9 (81.8)
Ulcer classification (UT), n (%)	
Grade 1A	9 (81.8)
Grade 1B	1 (9.1)
Grade 3B	1 (9.1)
Preulcerative lesions, n (%)	
Total	41
Digit 2	16 (39)
Digit 3	16 (39)
Digit 4	8 (19.5)
Digit 5	1 (2.4)
Previous history of ulcer	17 (41.5)
Toe deformity (with ulcer and preulcerative lesion), n (%)	
Total	52
Claw toe	50 (96.2)
Hammer toe	1 (1.9)
Mallet toe	1 (1.9)
Previous treatment, n	
Podiatry	17
General practitioner	3
No treatment	3

Smith, Simon E and Julie Miller, 'The Safety and Effectiveness of the Percutaneous Flexor Tenotomy in Healing Neuropathic Apical Toe Ulcers in the Outpatient Setting' (2020) 13(2) *Foot and ankle specialist* 123

"The Australian Burden of Disease Study 2011 estimated that 1.7% (12,300) of people with diabetes in Australia experienced lower limb amputation. Health loss, as a direct result of diabetes-related lower limb amputation, accounted for 456 years of healthy life lost due to living with disability in Australia in 2011"

Example 1: Apical ulcer

Pre-op

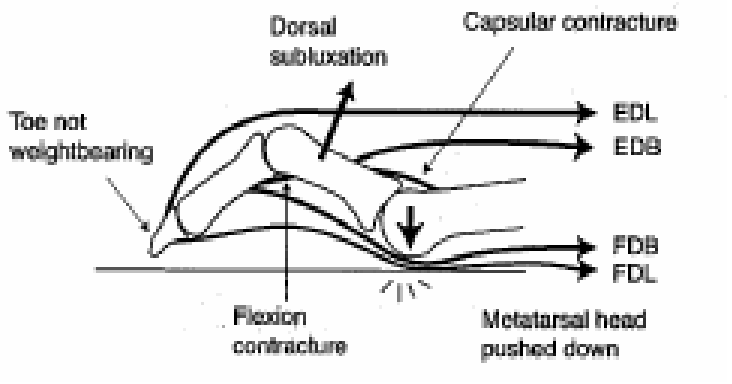
2yr Post-op

Example 2:
Distal ulcer/infection

1yr Post-op

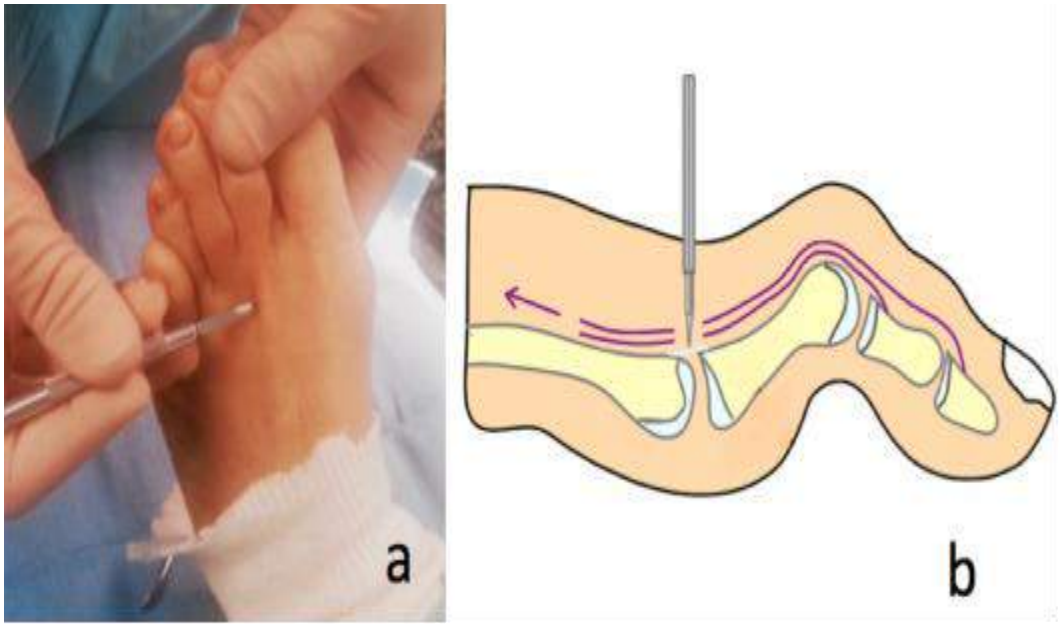
Extensor tenotomy

- Suitable for elderly patients
- Simple
- Relief of painful dorsal lesions
- Tenotomy + dorsal capsulotomy for hyperextended 5th toe?
- Good addition to FDL with kissing and dorsal ulcers
- Good for extensor substitution



Banks, et al (2004)

Extensor tenotomy/Capsulotomy-addressing sagittal and transverse plane deformity



Extensor tenotomy

- After care
  - No sutures required
  - Dress with digit in corrected position
  - Maintain with digital device for 4-8/52+
- Possible complications
  - Infection
  - Return of deformity
  - Flail toe
  - Transfer loading

Sanz-Corbalán, Lázaro-Martínez, 'Digital Deformity Assessment Prior to Percutaneous Flexor Tenotomy for Managing Diabetic Foot Ulcers on the Toes' (2019) 58(3) *The Journal of foot and ankle surgery* 453

ABSTRACT

The aim of this study is to evaluate the prevalence of digital deformities in patients with diabetes mellitus according to the McGlamry classification and relate the types of digital deformities with the history of digital ulcer. A cross-sectional study was performed in the diabetic foot unit between September 2016 and September 2017. All consecutive patients were classified by digital deformities according to the McGlamry classification (flexor stabilization, flexor substitution, and extensor substitution) using slow-motion videos. In all patients, the Foot Posture Index 6 was performed and previous toe ulceration, toe calluses, and nail dystrophy were evaluated. A total of 142 feet were evaluated, in which 29 (20.27%) feet did not show dynamic deformities, 65 (57.5%) were classified as flexor stabilization, 9 (8%) as flexor substitution, and 39 (34.5%) as extensor substitution. In total, 23% the feet with previous ulcer were classified as extensor substitution. A previous toe ulcer on the tip ($p = .033$; confidence interval [CI] 1.06 to 4.99; odds ratio [OR] 2.3), pronated foot according to the Foot Posture Index 6 ($p = .048$; 95% CI 0.9 to 8.9; OR 2.9), and callus on the tip ($p = .002$; 95% CI 1.47 to 6.41; OR 3.07) were associated with flexor stabilization deformities. Flexor stabilization, associated with the pronated foot, was the most prevalent dynamic deformity. Extensor substitution was present in approximately 40% of the patients and in 20% of the patients with previous ulcer, in whom flexor tenotomy could aggravate the digital deformity. An evaluation of dynamic deformities during gait should be included as a presurgical assessment to achieve successful surgical results.

Effectiveness of percutaneous flexor tenotomies for the management and prevention of recurrence of diabetic toe ulcers: a systematic review

Jennifer E. Scott, Gordon J. Hendry* and John Locke

Abstract

Background: Diabetic toe ulcers are a potentially devastating complication of diabetes. In recent years, the percutaneous flexor tenotomy procedure for the correction of flexible claw and hammer-toe contraction deformities has been proposed as a safe and effective technique for facilitating the healing of toe-deformity related diabetic ulcers. The aim of this review is to critically appraise the evidence for the effectiveness of this surgical procedure in achieving ulcer healing, prevention of re-ulceration, and to summarise the rate of post-operative complications.

Method: A search of medical databases, was performed to locate relevant literature. Titles were screened prior to abstract and full text review to identify articles relevant to the research question. Search terms included truncations of "tenotomy", "toe", "hallux", "digit", "diabetes" and "ulcer". Peer reviewed primary research study designs specified as suitable for systematic reviews by the Centre for Reviews and Dissemination were included. Studies were excluded if they used a concurrent secondary procedure or included non-diabetic patients without reporting outcomes separately. Included studies were appraised for quality using the Methodological Index for Non-Randomised Studies tool. Levels of evidence were subsequently assigned to each outcome of interest (healing rate and prevention of re-ulceration).

Results: From a total search yield of 42 articles, 5 eligible studies (all case series designs) were identified for inclusion. Included studies were of low-to-moderate methodological quality when assessed using the MINORS tool. A total of 250 flexor tenotomy procedures were performed in a total of 163 patients. Included studies generally reported good healing rates (92–100 % within 2 months) post-op follow-up), relatively few recurrences (0–18 % at 22 months median post-op follow-up), and low incidences of infection or new deformity. Transfer ulcers developing on adjacent areas as a result of shifted pressure were reported by several authors.
The validity of these results is undermined by methodological limitations inherent to case series designs such as a lack of control groups, non-randomised designs, as well as inconsistent reporting of post-intervention follow-up periods. There was level 4 evidence for the flexor tenotomy procedure in facilitating ulcer healing and preventing re-ulceration.

Conclusion: More definitive research evidence is needed in this area to determine whether or not the flexor tenotomy is a safe and effective treatment option for people with, or at risk of developing diabetic toe ulcers. Whilst the available literature reports that the procedure may be associated with high healing rates, relatively low recurrence rates and low incidences of post-op complications, methodological limitations restrict the value of these findings.

Keywords: Flexor tenotomy, Toe ulcer, Diabetes, Ulceration, Plantar pressure, Toe deformity

Rasmussen, Bjerre-Christensen, 'Percutaneous Flexor Tenotomy for Preventing and Treating Toe Ulcers in People with Diabetes Mellitus' (2013) 22(3) *Journal of tissue viability* 68

Abstract *Introduction:* The purpose was to examine the effectiveness of flexor tenotomy in a modified technique to prevent and heal neuropathic and neuroischaemic pressure ulcers on the tip of the toe in claw- or hammer-toe deformities in people with diabetes.
Patients and methods: A consequetive 4 years series of 38 patients was retrospectively studied. Percutaneous tenotomy on the superficial and deep flexor tendons was performed in 65 toes through a small transverse plantar stab incision just proximal to the web level. There were 16 (42%) patients with 27 ulcerated toes and 22 (58%) patients with 38 toes with impending ulceration. Ten patients had neuropathic ulcers and six patients had neuro-ischaemic ulcers. Sixteen patients (42%) had macrovascular disease. Ten (26%) had proliferative retinopathy, 7 (18%) macroalbuminuria and 18 (47%) microalbuminuria.
Results: All surgical incisions healed uneventfully. Twenty-five (93%) of the toe ulcers healed in median 21 days (range 7–224 days). Three patients had recurrence of the ulcer. There were no infections in the incisions or toe amputations. No patients treated with preventive tenotomy experienced toe ulceration. No complications were recorded in neuro-ischaemic ulcers. During the follow up period of median 31 months (range 2–48 months) 33 other ulcers were recorded in 18 patients (47%). One of these developed a transfer ulceration under the adjacent metatarso-phalangeal joint and another had a late pressure ulcer on a neighbouring toe. The other 31 ulcers were not related to ulcers treated with tenotomy.
Conclusion: Tenotomy is a simple, safe and effective procedure for preventing and treating distal plantar neuropathic toe ulcers in claw toe or hammer toe deformities in people with diabetes with or without serious co-morbidity. The results suggest that tenotomy should be considered also in neuroischaemic ulcers.

Future Studies/Conclusion

- The most common site of ulcer in diabetics-toes

Toe ulcers may precede up to 64% of diabetic limb amputations

- Flexor tenotomies are safe in the treatment and prevention of diabetic foot ulcers

The International Working Group on the Diabetic Foot 2015 Guidance Document recommends that digital flexor tenotomy should be considered to prevent a toe ulcer when conservative treatment fails in a high-risk patient with diabetes, hammer toes, and either a preulcerative sign or an ulcer on the toe

- Case controls/Randomized trials
- Plantar pressure measurements

Acknowledgement

- Dr Alan Bryant for sharing slides of before and after flexor tenotomies

Suggested reading and References

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Surname _____ First Name _____

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REASON FOR REFERRAL

ADDITIONAL COMMENTS

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