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Review

Treatment of dynamic claw toe deformity flexor digitorum brevis tendon transfer to interosseous and lumbrical muscles: A literature survey

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ABSTRACT

The authors report the results of a literature survey of corrective surgical treatment based on FDL and FDB tendon transfer for dynamic claw toe deformities. The study revealed that FDL transfer was first described in 1967 by Malcolm A. Brahms in "Common Foot Problems", and FDB transfer was first mentioned in 1993 in the first edition of the treatise by G. Pisani "*Trattato di Chirurgia del Piede*".

The paper also discusses the functional effect of FDB transfer, compared to FDL transfer.

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1. An outline of functional anatomy [1]

Claw toe is characterised by deformities during hyperextension of metatarsophalangeal (MP) joints and during flexion of both proximal and distal interphalangeal joints (PIP, DIP).

The of extensor tendons, which raise the skin that covers metatarsophalangeal joints can be clinically observed.

Dynamic claw toe can be passively corrected by exerting plantar pressure on the corresponding metatarsal head to realign the toe.

Dynamic claw toe can be fully corrected with the aforementioned semeiological manoeuvre, unlike claw toes resulting from compartment syndrome, for instance, in which case metatarsophalangeal extension can be corrected but residual interphalangeal flexion deformity is enhanced.

Neurological diseases are the most frequent cause of claw toes; especially, hollow foot (either essential cavus or with a known aetiology) is the deformity that is most associated with claw toe, both of lesser toes and of the hallux.

This hospital distinguishes claw toe "with" hollow foot (primitive form subsequent to a deficiency in interosseous and lumbrical muscles) from the one resulting "from" hollow foot (secondary claw toe, a consequence of equinism of metatarsal bones and dorsal displacement of interosseous and lumbrical muscles to the centre of rotation of individual metatarsal heads).

Dynamic claw toes can often only be observed while a person is walking, since they are not noticeable during clinical examination of the loaded foot.

The latter can be observed either during the swing phase of the step (due to AT deficiency and EDC compensation with inadequate interosseous and lumbrical muscles), or during the lift-off phase of the foot from the ground (due to triceps surae deficiency and an attempt at FDL compensation with MP destabilised by interosseous and lumbrical muscles).

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Besides the aforementioned forms whose aetiology is "known", we often find dynamic claw toes – almost always in women – whose aetiology can only be theorized. We think that the use of "elegant" constricting shoes, which at times have high heels that make the foot slide forward, can offer a valid pathogenetic explanation. In fact, metatarsal constriction caused by such footwear can cause intermetatarsal intrinsic muscle distress (lumbrical and interosseous muscles) with subsequent hypotrophy and myogenic deficiency of the same, leading to the deformity.

All cases of dynamic claw toes present dyskinesia between intrinsic and extrinsic muscles with failure of lumbrical and interosseous muscles (failure to stabilise metatarsophalangeal joints and deficiency of the so-called "beam effect"), "prevalence" of FDBs (plantar flexion of intermediate phalanxes) and maintenance of the deformity by the extensors, which intervene as an external factor in the pathological process of claw toes.

Hence, it is the rational therapeutic choice of our Centre to use FDB tendons through their dorsal transfer to the first phalanx in cases of dynamic claw toes [2].

FDB transfer both compensates for the functional deficiency of lumbrical and interosseous muscles and also "eliminates" the "relative prevalence" of flexion on the second phalanx, with a subsequent "gain" in the synergic balance of toe muscles.

2. A literature survey

In 1947 Girdlestone described FDL transfer combined with FDB transfer [3].

In 1951 Taylor [4] described his transfer technique and the clinical results achieved, hence the current term "Girdlestone-Taylor procedure".

In 1958 Pyper [5] reported stiffness in PIP joints after FDL transfer, and proposed concurrent arthrodesis of the same.

The first detailed description of FDL transfer – longitudinally divided into two hemitendons and dorsally taken to P1 – in the treatment of neurological claw toes is usually attributed to Parrish [6].

Several publications later report the experience of their authors with FDL transfer [7–12].

Dorsal FDL transfer as surgical treatment for claw toes has been discussed even in recently published literature [13], but the method is not free of criticism.

Claw toe is the result of the "functional prevalence" of FDB and not of FDL; therefore, sacrificing FDL does not prevent FDB from prevailing.

The FDL transfer technique is well illustrated in Lower D. Lutter's Atlas of Adult Foot and Ankle Surgery (1997), which calls such surgery "Taylor-Girdlestone flexor-extensor transfer." [14]

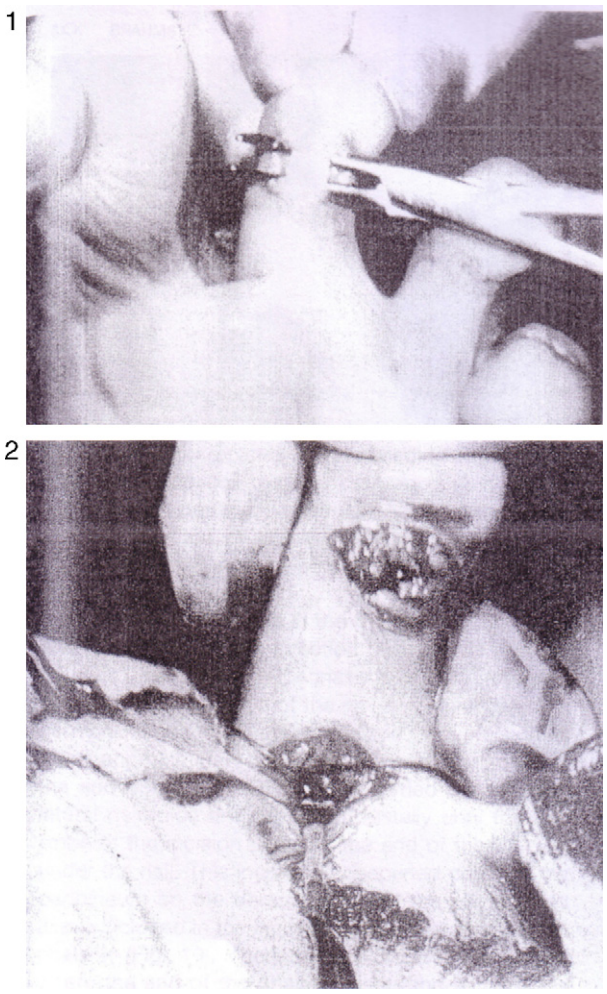
Concerning FDB transfer as treatment for claw toe, the literature consulted reports that in a paper published in 1973 Parrish describes his surgical experience with five patients and that he was forced to abandon the method due to technical difficulties, adopting FDL transfer for the other 18 patients of the 23 reported in his publication [6].

Therefore, in the aforementioned paper Thomas Parrish only refers to FDL tendon transfer as the surgical technique adopted by him.

Malcolm A. Brahms has been acknowledged the merit of first proposing FDB transfer in a paper published in 1967 [15].

But his description of surgery does not refer to the transferred tendon as FDB, since he generally speaks of "flexor" tendon transfer. Moreover the technique described and figures published lead one to understand that the transferred tendon was most likely FDL and not FDB (Figs. 1 and 2).

Our theory is confirmed by A. S. Edmonson in the chapter he edited on Postural Deformities, Volume 4 of the Treaty "*Chirurgia Ortopedica*" by Campbell, A. H. Crenshaw (1975). On page 1921 he says: *Mallet finger without stiffness (Brahms' Technique).* <<*...identify and detach the FDL tendon from its insertion on the last phalanx...*>> [16]



Figs. 1 and 2. Double plantar incision for FDL tendon isolation, detachment and transfer.

Hence, consistency demands authorship of the described dorsal FDL transfer to the proximal phalanx after longitudinal division into two hemi-tendons to be acknowledged to Brahms (1967) and not to Parrish (1973). And, it is clear that the first proposal of surgically using FDB for this deformity cannot be attributed to Brahms anymore.

According to our survey, the first detailed surgical reference to FDB transfer was made by G. Pisani in his *Trattato di Chirurgia del Piede* (1993) [2].

The latest literature on FDB transfer for claw toe treatment reports studies conducted on corpses [17,18] and on biomechanical models [19,20] to evaluate tendon anatomy, surgical techniques and pressure applied on the phalanx after FDL or FDB dorsal transfer, and to study the biomechanics of intrinsic foot muscles.

In Volume One of F. Barca's recently published *Testo-Atlante di Patologia del Piede* the author mentions and describes the "*flexor-extensor FDB transfer*" technique, recommending it for mallet toes that can be limited to the PIP joint with no fixed MT deformities [21].

Therefore, it seems appropriate to describe the details of G. Pisani's FDB-lumbrical and interosseous muscles transfer, which has been adopted by our Centre since 1989. The results of a case history review of about 300 patients who were operated with this