

THE McGLAMRY ELEVATOR: Sketches and Ideas

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The McGlamry elevator is a specialized podiatric surgical instrument developed for a specific purpose. The McGlamry elevator is produced by KMedic, Inc. (Leonia, New Jersey) and is available through your local podiatric supplier. It was conceived, designed, and created by a podiatrist for podiatry to improve forefoot surgical outcomes. The anatomic basis of the instrumentation and the role it plays in the release of metatarsophalangeal joint (MTPJ) contracture will be reviewed, and indications and limitations will be presented. Theory and conjecture based on principle and experience are the foundation of this report. There is still a need for research and study in MTPJ and hammertoe surgery. The McGlamry elevator has been an integral part of the evolution of MTPJ surgery, however the conceptualization and research continues.

MTPJ FUNCTIONAL ANATOMY

Active flexor power to the proximal phalanges of the lesser toes is rather weak. It is provided primarily by the lumbrical muscles in the swing phase of gait, and the interossei muscles during the stance phase of gait. The majority of flexor power to the proximal phalanges of the lesser toes during the stance phase of gait is provided by the passive pull of the plantar fascia.

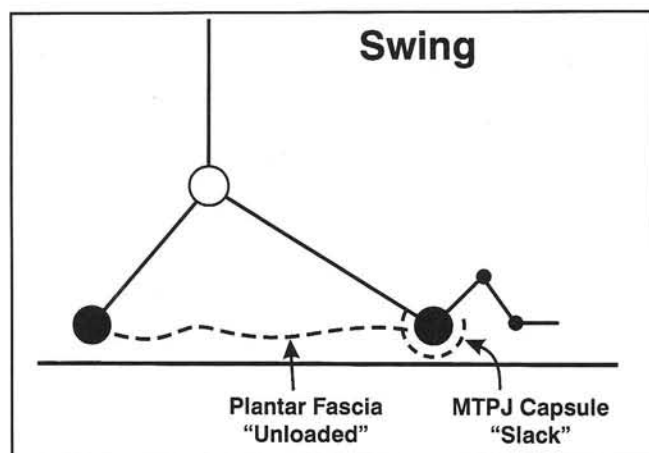


Figure 1A. The foot and plantar fascia in swing phase of gait.

The foot pronates through the midstance phase of gait and places the plantar fascia under tension. The plantar fascia, in functional terms, runs from the plantar calcaneal tuberosity through the plantar MTPJ flexor capsule and flexor plate to the bases of the proximal phalanges. The plantar fascia is fixed in terms of length. As the foot pronates and relatively elongates, the proximal phalanges are stabilized to the floor by the tension placed on the plantar fascia through pronation. As the midstance phase of gait progresses to the toe-off phase of gait, the recoil of the plantar fascia through the windlass effect actually aids in resupination. The plantar fascia and flexor plate act as a conjoined structure or strap of tissue that in functional terms runs from the calcaneus to the bases of the lesser toes plantarly. This strap of tissue is fixed at the heel and creates motion at the mobile MTPJ (Figs. 1A, 1B).

THE HAMMERTOE DEFORMITY AND THE MTPJ

Hammertoes and clawtoes are the result of multiple biomechanical and neuromuscular imbalances. These imbalances result in the characteristic digital sagittal plane deformity and contracture. A component of hammertoe or clawtoe deformity is extensor contracture of the MTPJ. MTPJ extensor

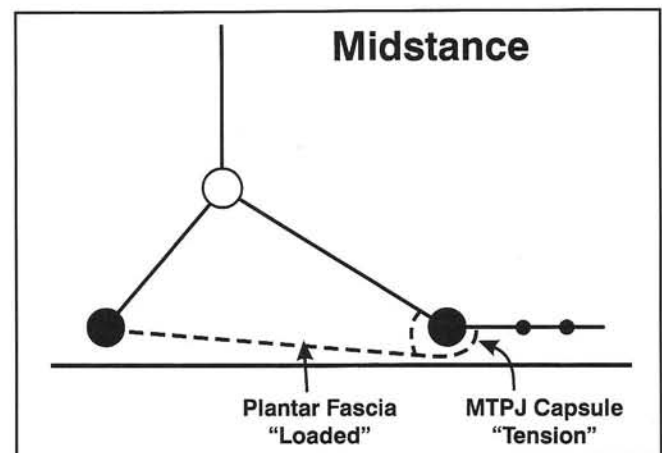


Figure 1B. The foot and plantar fascia in midstance phase of gait.

contracture can become more rigid as the hammer toe deformity progresses and develops. A rigidly contracted MTPJ binds the metatarsals plantarly reducing forefoot flexibility. Increased plantar forefoot pressures on gait-plate analysis are evident. Metatarsalgia and painful callous formation occur across the plantar forefoot area. The plantar fascia no longer stabilizes the proximal phalanges of the lesser toes to the floor. An extensor force on the MTPJ is exerted by the strong long flexor and long extensor tendons that overpowers the weak interossei, lumbricales, and the passive pull of the plantar fascia. Extensor contracture at the MTPJ develops as a result of this overpowering imbalance.

Further evidence of the plantarflexory forces exerted by the plantar fascia on the proximal phalanges can be noted in brachymetatarsia and dorsiflexed metatarsals following osteotomy or fracture. If the metatarsal does not load or purchase the weight-bearing surface, the plantar fascia and flexor capsule are not placed under tension. The proximal phalanx cannot be stabilized to the floor, as the plantar fascia is never placed under tension during the midstance phase of gait. The affected toe seems to float or rise from the floor, and does not purchase the ground during weight bearing (Fig. 2). The digital presentation is not a hammer toe in the classic sense, as the tip of the digit is away from the weight-bearing surface (Fig. 3). The floating toe associated with an elevated metatarsal represents an absence of passive flexor power through the plantar fascia to the proximal phalanx. The floating toe deformity does not occur as a result of long extensor and long flexor imbalance typically associated with most hammertoe or clawtoe deformities.

The key to understanding the release effect of the McGlamry elevator is to appreciate the insertional characteristics of the plantar fascia and flexor plate at the MTPJ, both in the normal toe and in the hammertoe deformity. Actual foot anatomic considerations must be extrapolated to functional concerns to understand the effects of the McGlamry elevator release. The plantar fascia with the flexor capsule and flexor plate of the MTPJ combine to add flexor power to the proximal phalanges and lesser digits in the normal foot. This power is lost in the hammertoe deformity with extension MTPJ contracture. In the hammertoe deformity, the plantar fascial insertion functionally becomes the proximal capsular attachment at the metatarsal

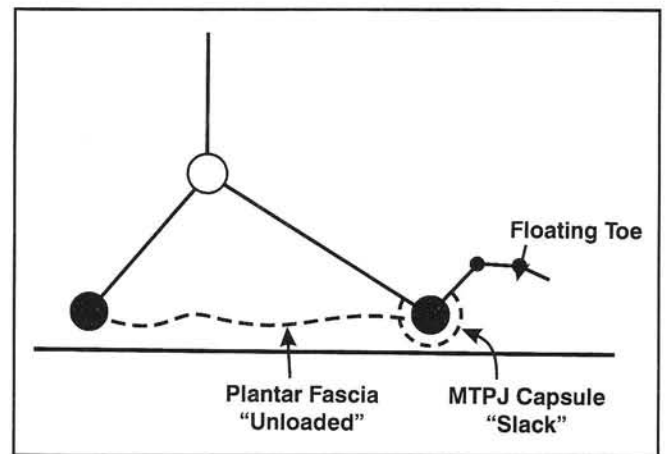


Figure 2. The foot in the midstance phase of gait with an elevated metatarsal and floating toe deformity.

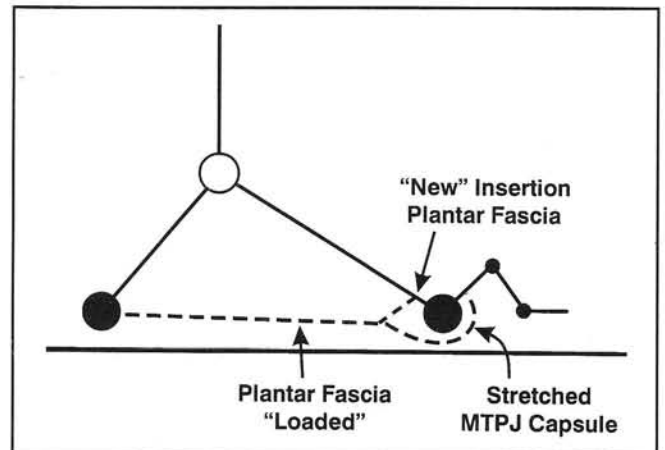


Figure 3. The foot in the midstance phase of gait with a hammertoe deformity.

neck, not the base of the proximal phalanx. The plantar capsule and flexor plate of the MTPJ from the metatarsal neck distally to the proximal phalanx is in maximum extension in hammertoe deformity. The natural redundancy of plantar capsular tissue to permit digital dorsiflexion at the MTPJ has been used up by the dorsiflexion of the proximal phalanx at the MTPJ. The MTPJ flexor capsule and flexor plate distal to the metatarsal neck may even become stretched and weakened as the MTPJ extension deformity of the hammertoe progresses. Fibrosis of the flexor capsule and flexor plate to the plantar metatarsal neck will reinforce an aberrant insertion of the plantar fascia at the metatarsal neck area instead of the phalangeal base.

Effective hammertoe and MTPJ surgical correction must then involve: 1. extensor tendon release (tenotomy/lengthening); 2. extensor hood release; 3. flexor release (arthroplasty/arthrodesis at

PIPJ level); 4. flexor capsule and flexor plate release (McGlamry elevator); and 5. intra-articular osseous reduction (proximal phalangeal base/metatarsal head resection); or 6. supplementation of flexor power assist (flexor transfer). These steps, when indicated, help achieve the two primary goals in hammertoe and MTPJ surgery, which are release of deformity and maintenance of correction. The first goal is to adequately release the MTPJ extensor contracture to allow the proximal phalanx to plantarflex to a normal anatomic position on the head of the metatarsal. This is accomplished through the sequential release of the MTPJ which may or may not include use of the McGlamry Elevator.

The second goal of MTPJ surgery is to re-establish flexor power to the proximal phalanx. By re-establishing flexor power, the position of correction of the MTPJ obtained intraoperatively can be more effectively maintained post-operatively. In some cases, flexor power to the proximal phalanx can be re-established through simple release of the MTPJ itself. Arthrodesis of the proximal interphalangeal joint converts the extensor power of the long flexor to a plantarflexory stabilizing force at the MTPJ. This flexor power transfer may be inadequate in some cases. The crossover hammertoe deformity or cases of severe inflammation at the lesser MTPJ may result in attenuation and stretching of the long flexor tendon, weakening its active plantarflexory power. Scarring and adhesions of the long flexor tendon at the MTPJ plantarly, can actually prevent active plantarflexion of the MTPJ. If the lesser metatarsal is overly dorsiflexed and is not weight bearing, as following osteotomy or fracture, flexor power to the proximal phalanx is reduced as well. Supplementation of this flexor power loss by flexor tendon transfer may be necessary to further supplement the ability of the proximal phalanx to purchase the floor at the midstance phase of gait.

THE McGLAMRY ELEVATOR, WHAT IT DOES

The McGlamry elevator can be conceptualized as an instrument that releases the proximal flexor capsular attachments of the lesser MTPJ at the metatarsal neck area. A functional strap of tissue is re-established from the calcaneus proximally to the bases of the proximal phalanges of the lesser toes

distally. This is why the instrument is passed proximally at the MTPJ to effect release towards the metatarsal neck, and not distally toward the phalangeal bases. Flexor release directed distally toward the phalangeal bases would sever the functional connection of the plantar fascia from the calcaneus to the digits. Distal passing of the instrument to effect plantar capsule and fascial release would result in adequate mobilization of plantar tissues, but compromise of the functional insertion of the plantar fascia would result. The plantar fascial continuity from origin to insertion must be maintained (Figs. 4A, 4B).

Once the release by the McGlamry elevator is attained, lesser metatarsal mobility is re-established. The proximal phalanx can plantarflex at the MTPJ as the metatarsal can again dorsiflex through the midtarsal joints and load the plantar fascia. Plantar weight bearing pressures across the forefoot are reduced. This can be demonstrated in force-plate

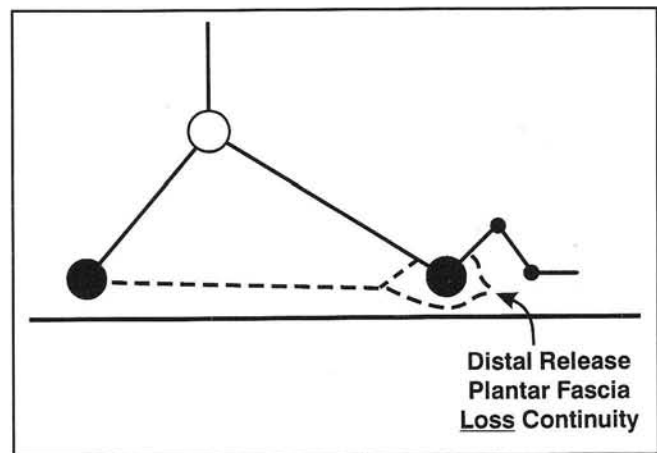


Figure 4A. The foot in the midstance phase of gait with distal release of the MTPJ capsule.

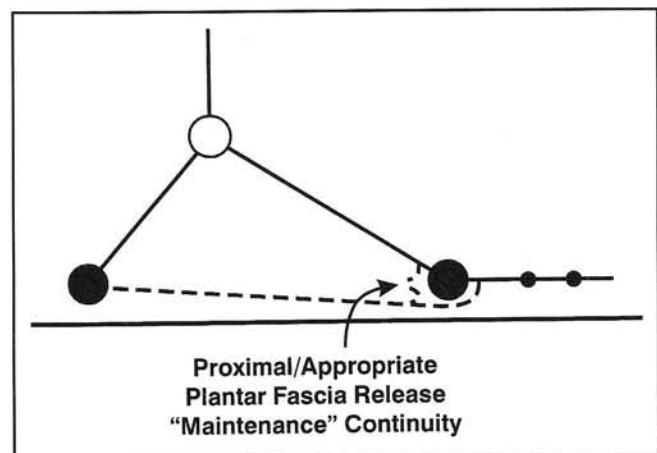


Figure 4B. Proximal release of the MTPJ capsule.

analysis following MTPJ release and hammertoe correction. As the foot pronates in the midstance phase of gait, the plantar fascia can act on the proximal phalanx again to aid in flexor digital stability. Surgical release of the MTPJ can be adequate to allow reduction of the extensor contracture, but inadequate to re-establish the critical flexor power mechanics of the plantar fascia to maintain the correction postoperatively.

THE McGLAMRY ELEVATOR, WHAT IT DOES NOT DO

There are limitations as to what the McGlamry elevator can be expected to effect at the MTPJ level. Flexor power stabilization to the proximal phalanx is critical in maintaining correction following effective MTPJ extensor release. Even with re-establishing passive pull through the plantar fascia, active pull of the flexor digitorum longus augmented by PIPJ arthrodesis and the interossei does not necessarily result in re-establishing adequate flexor power to the proximal phalanx in all cases. Even though re-establishing flexor power to the proximal phalanges is critical, it is not necessarily predictable in all clinical situations. Certain digital deformities seem more prone to float or not purchase the floor following MTPJ release, even in the face of PIPJ arthrodesis.

If metatarsal weight bearing is not adequately re-established, especially following metatarsal fracture or osteotomy, the plantar fascia does not load. Even with adequate MTPJ release, the toe may float even if PIPJ arthrodesis is performed. Crossover hammertoe deformities are potentially prone to float postoperatively following MTPJ extensor release and PIPJ arthrodesis. It may be that the inflammatory condition that creates the crossover hammertoe deformity results in flexor tendon attenuation, stretching, and weakening. The flexor capsule which is intimately involved with the insertion of the plantar fascia, may be shifted and weakened due to this inflammatory state. Even if adequate release of the MTPJ and PIPJ arthrodesis is performed, the toe may eventually float and mal-align postoperatively. Postoperative distal interphalangeal joint mallet toes may signify weakened flexor capsular tissues and overpowering of the long flexor as the digit attempts to stabilize itself to the floor. The proximal phalanx is elevated while the distal phalanx is pulled plantarly by the

long flexor, and mallet toe deformity develops postoperatively.

Another deformity prone to have inadequate flexor power re-established to the proximal phalanx postoperatively is the isolated second toe hammertoe with hallux abducto valgus. Here the flexor tendon may be stretched as an isolated component of the conjoined flexor tendons. The remaining three digital flexor tendons are not overly stretched in the absence of hammertoe deformity. Repair of the second digit hammertoe by PIPJ arthrodesis or arthroplasty can actually further weaken plantarflexory power to the proximal phalanx of the isolated second toe hammertoe. Further plantarflexory weakening results from the relative lengthening of the short and long flexor tendons which occur after the bony column shortening of PIPJ arthroplasty or arthrodesis. Lack of flexor power may again be noted with floating of the toe and associated mallet toe deformity postoperatively.

THEORETICAL SOLUTIONS

The McGlamry elevator was contoured and developed to effect release of the plantar capsule from the inferior metatarsal neck region. It performs this function extremely well. The contour and sizing of the instrumentation is very well adapted to this purpose. The curved distal edge of the instrument allows for the releasing of capsule from the plantar metatarsal neck area, not the cutting of plantar fascial continuity. If the instrument cuts the plantar fascia or inadvertently damages the plantar fascial strip to the base of the proximal phalanx, the effect would not be as desired in terms of maintaining the functional plantar strap of fascial tissue. The McGlamry elevator can be used inappropriately, and inadvertent release of the fascia in terms of its continuity could result.

The McGlamry elevator was not designed to re-establish flexor power to the proximal phalanx. A degree of plantarflexory power to the proximal phalanx is secondarily achieved through re-establishing the functional nature of the plantar fascia. Further plantarflexory power to the proximal phalanx can be obtained through the PIPJ fusion and converting of the long flexor into a plantarflexory stabilizer of the proximal phalanx. The degree of flexor power that can reasonably be

expected to be re-established to the proximal phalanx is unknown and difficult to predict. Only through analysis and study can specific digital deformities be identified that may require flexor transfer to the proximal phalanx to further facilitate plantarflexory stability.

Flexor power could be augmented to the proximal phalanx in a number of ways. Plantar digital sulcus skin plasties with removal of a small wedge of skin can aid in flexor power at the MTPJ level to a degree. Flexor transfer of the long flexor tendon into the base of the proximal phalanx could be considered even with MTPJ release and PIPJ arthrodesis. Tacking the long flexor tendon to the base of the proximal phalanx with a suture or mini-anchor may aid in postoperative plantarflexory stability to the proximal phalanx. Research is needed to help identify the indications and techniques to utilize flexor tendon transfers to augment plantarflexory stability of the proximal phalanx. Overzealous flexor power transfer to the proximal phalanx could result in lesser MTPJ limitus and prevention of adequate digital dorsiflexion and possible postoperative problems.

The McGlamry elevator is an innovative surgical tool that greatly improves the results of MTPJ and hammertoe surgery. It has stood the test of time as a vital instrument in the podiatry packs of many hospitals. There are limitations on expectations for postoperative results. These limitations are primarily in flexor power to the proximal phalanx. The instrumentation must be understood in terms of concept and design to help the surgeon more fully understand its use and limitations. A review of use and ideas for effectively releasing the MTPJ have been presented. It is hoped more discussion and research will be encouraged by this review.

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