Lesser Metatarsalgia: Are Lesser Metatarsal Osteotomies Necessary?

Carefully considering the biomechanical factors that contribute to lesser metatarsalgia, these authors advocate and offer insights on combining a modified Hibbs procedure and a Girdlestone-Taylor procedure to maximize outcomes without the complications of a metatarsal osteotomy.

Metatarsalgia refers to localized and generalized pain at the forefoot, specifically at the plantar aspect of the metatarsal heads with either mechanical or iatrogenic etiology. The surgical management of this pathology remains an area of debate as various authors have described multiple procedures and approaches. Accordingly, it is of utmost importance to identify the biomechanical factors and different etiologies influencing the pathology. Treatments include digital procedures, various metatarsal osteotomies, lesser metatarsophalangeal joint (MPJ) arthrodesis, metatarsal head resections, ancillary posterior muscle group lengthening and medial column procedures.

A Guide To Metatarsalgia Classification

In order to appropriately analyze and formulate treatment strategies adequately, it is important to classify the etiology behind the pathology accurately. This can be subclassified into primary, secondary and iatrogenic metatarsalgia.

Primary metatarsalgia. Primary metatarsalgia refers to pathology resulting from direct abnormalities in the patient’s anatomy (such as a plantar plate tear, hammertoe conditions that involve extensor recruitment and flexion contracture, etc.). This would include a tight heel cord and hypermobile first ray, which would result in excess loading and propulsion at the level of the lesser MPJs. Greisberg and colleagues in 2010 confirmed through their case series of 352 patients that patients with metatarsalgia have a higher dynamic metatarsal elevation (first ray hypermobility) in comparison to those patients without metatarsalgia.

Secondary metatarsalgia. Secondary metatarsalgia is a result of systemic conditions such as inflammatory arthropathy, gout, Freiberg’s infraction, tarsal tunnel syndrome and Morton’s neuroma. Additionally, symptoms of post-traumatic injury can shift the plantar pressure and lead to fat pad atrophy, which may exacerbate the symptoms. In addition, the effect of those conditions can result in hyperextension of the MPJ and result in pain similar to mechanical metatarsalgia.

Iatrogenic metatarsalgia. Iatrogenic metatarsalgia may arise from malalignment of a previous metatarsal osteotomy or from metatarsal head resection. In addition, inherent surgical problems like nonunion, delayed union, failed hallux ab ducto valgus surgery and inappropriate procedure selection for the correction of hallux ab ducto valgus can lead to the transfer of ground reactive forces and overload shift of the adjacent metatarsals. One of the most common causes is the iatrogenic shortening of second metatarsal osteotomies. Elevation of the second ray may lead to third rocker metatarsalgia while shortening the second ray may lead to second rocker metatarsalgia. Finally, hallux valgus surgery that results in elevation of the first ray can also cause a lateral shift of plantar pressures to the lesser metatarsal bones.

Understanding The Dynamics Of First Ray Mobility

For the purpose of this article, we will focus our discussion on primary metatarsalgia and concentrate on exploring the biomechanical etiologies contributing to this deformity, starting with the first ray function. Duchene was the first to consider the existence of first ray instability and Morton later theorized that this insufficiency contributes to further pedal pathologies, including lesser metatarsalgia.

By definition, the first ray includes the medial joints of the first metatarsocuneiform and the naviculocuneiform. The first ray and medial column act as a rigid lever during the heel rise phase of the gait cycle. Once the gastrocnemius...
complex contracts, the foot plantarflexes and rotates around the center of the talar body. Accordingly, the forces of weightbearing and Achilles tendon tension transmit to the ground through the medial column and first ray in order to propel the body forward.5

Approximately 60 percent of normal weightbearing forces pass through the first ray from heel strike to toe-off.7 Once the first ray fails to support the load, the medial column collapses, which leads to a lateral load shift to the lesser metatarsals. Morton proposed that the unstable first ray is an inherent cause of second metatarsal pathology.6 Greisberg and co-workers reported similar findings as patients with second MPJ synovitis and metatarsalgia noted greater first ray mobility.4

Furthermore, the instability of the first ray may also be visible at the frontal plane level as medial angulation of the first metatarsal through the first metatarsocuneiform joint contributing to the hallux valgus deformity. In fact, some studies have demonstrated increased sagittal plane mobility in patients with hallux valgus, thereby contributing to transfer metatarsalgia.4

**Keys To Addressing Lesser Metatarsalgia**

From our experience, we believe that the most predictable approach to lesser metatarsalgia is addressing the primary biomechanical pathologies that contribute to the presenting deformities. The initial step involves addressing the tight posterior muscle groups in patients with a confirmed equinus deformity via the Silfverskiold test. This occurs through tendo-Achilles lengthening in the case of gastroc-soleus equinus or through the endoscopic/open gastrocnemius recession approach in cases of gastrocnemius equinus. In doing so, the compensatory excess motion in the first ray decreases, thus lowering the load on the lesser metatarsals.

Grebing and Coughlin successfully demonstrated the relationship of ankle position with the first ray mobility.8 They found that with the ankle joint plantarflexed and dorsiflexed, the first ray mobilities were larger and smaller, respectively, than when the testing occurred with the ankle in neutral position.

Furthermore, the Lapidus arthrodesis can stabilize the first ray and recreate a rigid lever arm through the medial column to absorb the ground reactive forces during weightbearing. The procedure is predictable in stabilizing the first ray in three planes with emphasis on the sagittal, frontal and intermetatarsal angles.9

These cases are associated with digital deformities as a result of retrograde lesser MPJ buckling, instability resulting in metatarsalgia, MPJ instability, lesser digit contracture and anterior muscle group weakness. One can correct these deformities in an attempt to balance the pathologic anatomic deformities.

**Essential Surgical Pearls**

The surgeon should employ a modified Hibbs procedure along with a Girdlestone-Taylor procedure. In doing so, one recruits the proximal extensor digitorum longus tendons and transfers them to the dorsal lateral foot to aid in ankle joint dorsiflexion while transferring the proximal extensor digitorum brevis tendons into the distal extensor digitorum longus tendon slips under physiologic tension. Essentially, these steps “weaken” the dorsiflexors of the toes.

Additionally, we perform a modified Girdlestone-Taylor procedure with the transfer of the flexor digitorum longus tendon to the extensor hood, release of the flexor digitorum brevis tendon insertions at the base of the middle phalanx (both medial and lateral slips), and a capsulotomy at the level of the proximal interphalangeal joint. We then use a Kirschner wire to temporarily stabilize the digit.

The modified Hibbs procedure is indicated for patients who exhibit isolated extensor substitution/recruitment or global extensor substitution/recruitment to the forefoot. Dorsal subluxations/dislocations at the MPJ are frequently linked with claw toes and hammertoes. These deformities typically result with the recruitment of a tight extensor digitorum longus (extensor substitution/recruitment) to support dorsiflexion against a tight posterior muscle group (equinus deformity).

Great care of the soft tissue is essential and fine double skin hooks are recommended for retraction in order to avoid soft tissue compromise.

Identify the extensor tendons (extensor digitorum longus and brevis) and separate only these tendons from the subcutaneous tissues. One should separate and track these longitudinally, and use caution to avoid neurovascular structures.

Isolate the second extensor digitorum longus tendon. Tenotomize and clamp the tendon using an Allis clamp as far proximal within the incision as possible. Tenotomize the extensor digitorum brevis tendons as far distal as possible (at the metatarsophalangeal joint level).

Perform a complete capsulotomy at the MPJ. This facilitates release of all contractures via sharp dissection and a McGlamry elevator, which allows for anatomic restoration of the metatarsophalangeal joint. In cases in which there is transverse plane pathology such as a crossover hammertoe, one can correct the transverse plane with a release of the necessary soft tissue.
Proceed to address flexion contractures via a Girdlestone–Taylor procedure. At this time, remove all deforming forces from the deformity. The surgeon should subsequently be able to place the digit and align the toe in anatomic position to the MPJ in the desired position. Additionally, with the underlying deformity, the pathology should not be able to recur. Insert a 0.062 K-wire from the distal aspect of the toes through the distal interphalangeal joint, the proximal interphalangeal joint and the metatarsophalangeal joint to the base of the metatarsal. Ensure good anatomical alignment of the distal interphalangeal joint, the proximal interphalangeal joint and the MPJ.

Proceed to perform a tendon transfer (a weave graft) of the distal stump of the proximal extensor digitorum brevis into the most proximal portion of the distal extensor digitorum longus stump. Perform the transfer under physiological tension with the digits in good anatomic position. Pass the distal stump of the proximal extensor digitorum longus tendon into the midfoot. Perform this with the surgical assistant loading the foot 90 degrees relative to the leg. Be sure to suture the transfer of the tendon under physiologic tension for tendon balancing.

The modified Girdlestone-Taylor procedure is for flexion contractures of the distal interphalangeal joint and/or proximal interphalangeal joint. One can perform the procedure through a midline incision approach on the medial aspect of the toe. It is recommended that one use fine double skin hooks for retraction in order to avoid soft tissue compromise. Deepen the incisions in the same plane and be careful to avoid the neurovascular bundles. Identify the flexor digitorum longus and trace it distally to its attachment to the distal phalanx. Detach the distal aspect of the flexor digitorum longus from the distal phalanx and direct it proximal to the web space.

Proceed to direct your attention to the flexor digitorum brevis tendon. Perform a tenotomy (both the medial and lateral slips) and capsulotomy at the interphalangeal joint (for a flexion contracture of the proximal interphalangeal joint). If the distal interphalangeal joint is contracted, perform a capsulotomy there as well.

Insert a K-wire (preferably 0.062 inches) from the distal tip of the distal phalanx to the base of the proximal phalanx. With the toe in anatomical alignment (in relation to the metatarsal), suture the flexor digitorum longus tendon to the extensor soft tissue of the proximal phalanx under physiologic tension. This will aid in the plantarflexion of the toe.

**What Are The Advantages Of This Approach?**

With the scars located on the medial aspect of the second digit, the procedure leaves a much more cosmetically pleasing result. Postoperatively, there is a much more natural clinical look to the toes. The resulting bursa, hyperkeratosis and ulceration eventually dissipate as one corrects the deforming forces and relieves the pressures. Since the surgeon only performs a plantar joint capsulotomy, joint instability does not occur. Therefore, frontal (rotation) and transverse plane deviation deformities do not occur. There is no surgery on bone. Therefore, one can minimize the long-term edema that often occurs after bony procedures.

Additionally, since there is no surgery on the bony structures, there is no rotation, shifting, malalignment or shortening of the digits. The tendon transfer treats the underlying pathology: the dynamic deforming force of the tendon. Therefore, this eliminates the need to disturb the natural osseous structures of the three phalanges. After addressing the underlying pathology and removing the deforming forces, you can typically remove the K-wire after two weeks. Lastly, if there is a complication, one could always perform a bony procedure if necessary.

**In Conclusion**

There is some controversy with the treatment of lesser metatarsalgia as different schools of thought exist with variable levels of supporting evidence and success. We present an approach built on the understanding of pathomechanical factors associated with primary metatarsalgia. Addressing the equinus deformity, first ray instability and associated digital and lesser metatarsophalangeal joint instability are integral in providing a more predictable outcome.

Lesser metatarsal osteotomies do provide viable solutions in addressing lesser metatarsalgia and various authors have demonstrated this in the literature through various case series. However, these procedures do not offer long-term predictability and often have associated complications such as floating digits and transfer metatarsalgia.

A recent study by Peck and colleagues reviewed the outcomes of non-operative versus operative management of lesser MPJ instability. Operative techniques included the Weil osteotomy, lesser toe procedures and flexor to extensor tendon transfers. The authors reported no statistical difference in patient satisfaction and AOFAS scores over a mean follow-up of 55 and 70 months for operative and non-operative patients respectively. Accordingly, it is safe to deduce that while lesser metatarsal osteotomies have long-term benefits, there are also limitations that can be attributed to their inability to address the associated deforming forces.

Traditionally, lesser metatarsalgia has been associated with anatomic variations in the structure of the metatarsal bones, specifically "fixed" plantarflexed positions. The concept has been widely accepted in foot and ankle literature without supporting evidence. As a result, procedures strictly designed to address the isolated metatarsals cannot sustain the biomechanical forces that influence the instability at the lesser MPJs.
We need to revisit the notion of decompressing the “plantarflexed” metatarsals with more critical thought. As foot and ankle specialists, we should objectively consider how many of those lesser metatarsalgia patients have “plantarflexed” lesser rays, how are they plantarflexed relative to the other metatarsals, what caused this condition and finally, at what point during human development do those metatarsals assume the plantarflexed position?

Overall, it is important for the foot and ankle specialist to consider the following elements for lesser metatarsalgia presentations:
• etiology of the deformity;
• contributing biomechanical factors;
• conservative and surgical procedures addressing the etiologies; and
• the predictability of those surgical procedures

We present an approach to re-evaluate and reconsider lesser metatarsalgia management while examining the biomechanical factors that contribute to the clinical presentation. The approach offers a predictable measure with sound clinical evidence that has seldom been challenged in the foot and ankle literature.

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References

For further reading, see “How To Treat Lesser MPJ Disorders” in the June 2005 issue of Podiatry Today or “A Guide To Orthotic Treatment For Metatarsalgia” in the April 2012 issue. To access the archives, visit www.podiatrytoday.com.