Current Concepts in Treating Metatarsalgia

Understanding the etiology is the key to your treatment plan.

BY JACQUELINE M. BABOL, DPM

Metatarsalgia is a localized or generalized forefoot pain[1] usually due to overuse or excessive loading in the metatarsal heads that can be caused by a biomechanical dysfunction, an anatomical variation, or both. This article reviews current concepts pertaining to the central metatarsals 2, 3, and 4, although the surgical interventions to address this condition may also involve surgical management of the first and fifth ray. It has been estimated that 90% of foot disorders affect the forefoot. Dockery[2] reports that metatarsalgia is the most common cause of foot pain among middle-aged women.

Historically, the first paper written in literature regarding a metatarsal osteotomy was first described in 1916 by Meisenbach.[3] In 1985, in the U.S., Mann[4] presented a study on seven patients with 2nd metatarsophalangeal joint pain, in which six patients underwent early synovectomy with three of them undergoing resection of the common digital nerve.

"Static" versus "Propulsive" Callus

In reviewing the gait cycle, there is an eccentric contraction of the gastroc-soleus complex that occurs during the mid-stance period (second rocker). This occurs 10-30% into the gait cycle, when the foot is flat and the tibia glides over the talus.[5] Plantarflexion of the metatarsals can increase forefoot loading that can cause metatarsalgia. Besse[6] notes that this causes "static" metatarsalgia, and would show on your physical exam as a callosity that is more diffuse.

Figure 1: Metatarsalgia

Espinosa[7] writes that it could also present as an intractable plantar keratoma (IPK) that would show directly under the head of the metatarsal.

The third phase/rocker (30-60%) starts with heel rise, is controlled primarily by the gastroc-soleus component, and is responsible for propulsive metatarsalgia due to abnormal loading forces of longer metatarsals. Besse notes that the callus formed during this phase would more likely result in localized, punctate callus, or an IPK due to "propulsive" metatarsalgia. Espinosa[7] reports that the IPK formed would be slightly distal to the plantar aspect of the metatarsal head (Figure 1) .

Physical Exam for Metatarsalgia

Your standard practice should start with a complete history and review of systems. Ask your patient about previous orthopedic problems that may include back pain, one-sided joint pain in the foot, knee, or hips. Evaluate the patient's stance and in gait for any discrepancies in hip tilt, genu valgum or varum, early heel lift off, pronatory stance, or toe(s) not purchasing the ground. Observe for excessive supination or pronation of the foot.

Examine for hammertoe contractures, and note if they are reducible or not. Check for plantar pad displacements and location of calluses. Determine the point(s) of tenderness. Sullivan's sign on stance would show separation of the 3rd and 4th digits pathognomonic for neuromas. A separation between other toes might also indicate plantar plate tears.

A positive dorsal drawer test (Lachman test)[8] elicits a more than 2 mm dorsal dislocation of the base of the proximal phalanx when the base of the proximal phalanx is dorsally displaced with one hand and the head of the metatarsal is held in place with your other hand.

Plantar Plate Provocation Test

The plantar plate provocation test by Sanhudo[9] is performed with one hand pushing the base of the proximal phalanx down towards the MP joint, while at the same time dorsiflexing the MPJ. A positive test will elicit pain if there is a tear. For severe tears, plantar flexion of the MPJ should elicit pain. If you load the forefoot plantarly with one hand, all the ends of the digits should be on the same plane, while with a plantar plate tear, the digit would be elevated compared to the rest of the digits.

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Silverskold Testing

Silverskold testing[10] should be performed by having the subtalar joint locked in neutral position, the talonavicular stabilized, and dorsiflexing the ankle joint with the knee extended and flexed 30 degrees. If there is improvement or increase in ankle dorsiflexion with the knee flexed, then an isolated gastrocnemius equinus is present. Conversely, if passive dorsiflexion is limited in both knee extended and flexed positions, then a gastrocnemius-soleus equinus exists. Look for osteophytes along the dorsal aspect of the metatarsal head as this could indicate Frieberg's disease.

Various articles in the literature have categorized and classified metatarsalgia. In your examination, note if there is laxity of the MP joint or dislocation of the joint, and if the dislocation is reducible.[8] Coughlin[1] discusses a 4-stage deformity categorizing metatarsalgia due to digital deformities. Note if the digital deformity would be amenable to tendon transfers, arthroplasties, or arthrodesis, depending on the amount of reduction of the digital deformities achieved.

Diagnostic Imaging Tests

X-rays, ultrasound, and MRI will aid your differential diagnosis, which might include neuromas, metatarsalgia, tenosynovitis, bursitis and/or plantar plate tears. AP x-rays should be evaluated for 1st intermetatarsal angles and a distal metatarsal parabola. Lateral and medial oblique views should be used to evaluate digital contractures. Sesamoid axial views can be taken to check for plantarflexion of metatarsals.

Ultrasound is a less expensive way of evaluating plantar plate tears and neuromas. Remember to examine the contralateral foot in your examination for comparison studies. MRI studies would be very sensitive and specific for finalizing the diagnosis.

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Classification of Metatarsalgia

After your examination and evaluation, you can begin to classify the metatarsalgia. There are 3 primary classifications[2] of metatarsalgia. Primary metatarsalgia can be caused by a plantarflexed[14] and/or elongated metatarsal that can be caused by equinus,[15] metatarsus primus elevatus, or contracture of the gastroc-soleus complex. An abnormally enlarged metatarsal head due to congenital, traumatic, tumorous, or infectious causes can also fall under this category.

Secondary metatarsalgia occurs due to distal displacement of the fat pad, or conditions that overload the forefoot in general. Examples of these include neuromas, bursitis, Frieberg's disease, arthritidies, systemic inflammatory conditions, or metabolic disorders.

Iatrogenic metatarsalgia occurs due to post-surgical complications that cause abnormal loading of the metatarsal. Hallux valgus surgeries resulting in elevatus, metatarsal head resection, or osteotomies that cause a shift in load to the adjacent metatarsal heads are prime examples. Limb-length discrepancies, whether inherent, structural, or functional, can also alter gait biomechanics and affect load, causing metatarsalgia.[11]

Borne[16] discusses plantar plate tears that have 5 categories:

0. Normal
1. Synovitis
2. Plantar plate sculpture sometimes only seen with dynamic testing
3. Plantar plate rupture that is reducible, and
4. Non-reducible.

Conservative Care

Conservative care for metatarsalgia includes rest, NSAIDs, padding, splinting, orthotics, stretching, palliation, injections, and shoe modifications. Shockwave therapy (ESWT)[12] has also been used for this condition with good results.

Some common orthotic modifications that might be useful to alleviate symptoms include: adding a heel lift to address the equinus, use of minimum arch fill to have room for the metatarsal bar that could use cut-outs or punches to balance the weight of the metatarsal heads with the objective of floating the callosity representing the elongated and/or plantarflexed metatarsal.

For the plantarflexed first ray, a first ray cut-out with or without a reverse Morton's extension is ideal. For hallux rigidus, one can add a Morton's extension. A Cluffy wedge could also be used for hallux limitus. A medial skive modification should be used to address the pronatory component. The commercial Budin splint has been useful for floating toes instead of taping the toes down. In order to remove the abnormal amount of pressure off the forefoot, the patient should be advised to wear thick-soled or rocker bar shoes.

Controversy exists in using cortisone injections for metatarsophalangeal joint synovitis due to possible rupture of the plantar capsule.

Most of these patients presenting with metatarsalgia or forefoot pain come to your office wanting to have the callus removed to alleviate the symptoms of pain, although studies have proven that the recurrence re-

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mains high if the reason for having the callus is not addressed.

Studies have shown that active and passive stretching for six weeks will increase the ankle dorsiflexion range of motion. Have the patient perform active and passive stretching exercises at home or with a therapist. Keep in mind, however, that there is no study directly correlating that an increase in ankle range of motion will remove the pain associated with metatarsalgia.[13]

Controversy exists in using cortisone injections for metatarsophalangeal joint synovitis due to possible rupture of the plantar capsule. Current literature[6] supports its use as the treatment of choice for synovitis with MTPJ instability with taping of the digit in the plantarflexed position and protective weight-bearing for six weeks. Besse advises to refrain from giving injections due to the possibility of rupture.

Several Treatment Algorithms Have Been Written

Lopez, et al.[17] created a decision-making treatment algorithm based on whether the metatarsalgia is based on static versus dynamic factors.

Figure 3: Maceira's Three Cut Osteotomy

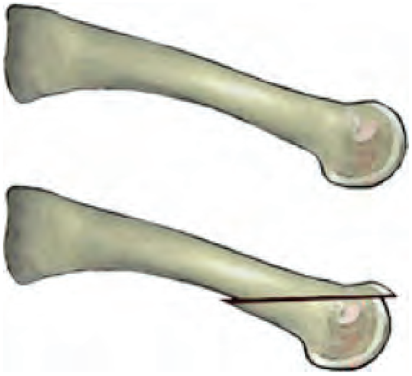

Figure 2: Weil Osteotomy

Espinosa, et al.[7] based their criteria of decision-making on the first ray dynamics, with midfoot or hindfoot abnormalities, normal or abnormal Maestro curve (metatarsal parabola), MTP joint instability, degenerative joint disease, and constitutional pes cavus.

Chahal, et al.[18] summarizes surgical treatment of metatarsalgia into soft tissue and bone procedures. To address the equinus that causes the metatarsalgia, a gastrocnemius recession is indicated after failure of conservative measures. The Strayer procedure is particularly useful in that it releases the medial head of the proximal aponeurosis.

For a flexible claw toe deformity, a GIrdlestone-Taylor procedure is indicated. This procedure involves the transfer of the flexor digitorum longus into the dorsal aspect of the extensor aponeurosis to stabilize the metatarsophalangeal joint. Other soft tissue releases may include MTP joint release and lengthening of the extensor tendons. Performing the Weil osteotomy with repair of the plantar plate using the mini scorpion and drilling through the base of the proximal phalanges removes the need to perform this procedure.

Plantar plate repair could be performed when indicated from a plantar incision or through a dorsal incision, if an osteotomy is also indicated. Literature reviewed by this author all agree that if the first ray caused the second ray pathology, correction of the first ray deformity is indicated.

There have been a wide variety of osteotomies discussed to address metatarsalgia. Chaha, et al. simplifies the list by categorizing them according to osteotomy site (basal, diaphysis, or distal) or procedures that affect biomechanics (shortening and/or elevation).

For "propulsive" metatarsalgia caused by elongated metatarsals, the objective is to shorten the metatarsal; the Weil osteotomy is the most favored (Figure 2).

For "static" metatarsalgia where there is no need to shorten, Henry, et al.[20] report of a percutaneous approach to distal metatarsal osteotomies (DMMO) on 2, 3, and 4. Utilizing a #11 blade, a periosteal elevator, and a power burr, osteotomies starting from the lateral, plantar, medial, and finally dorsal cortex are performed using a low speed burr (less than 8,000 rpm). Henry, et al. performed a study on 72 cases comparing the post-op results of patients who have undergone the Weil-type osteotomy versus DMMO. After one year, there were no differences in MTP motion or residual metatarsalgia. There was, however, longer duration of edema and pain in those having the DMMO procedure during the first three months (59% versus 29% on pain, and 24% versus 7% on residual metatarsalgia). Haque, et al.[20] report a 13% complication rate (non-union, mal-union, and transfer metatarsalgia) from their study of percutaneous DMMOs in 2016.[21]

Silastic implants as well as metatarsal head resections for rheumatoid

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arthritic patients can also be alternative choices in treating metatarsalgia.

Pre-operative Planning

Several methods of calculating metatarsal parabola vary in methods and even in results. Coughlin, Maestro, and Hardy and Clapham[27] all presented different ways to calculate metatarsal parabola with different results. Coughlin's showed normal relative protrusion of the second metatarsal relative to the first by an average of 4 mm. Maestro and Hardy showed 3 mm and Clapham showed a relative retraction of the second metatarsal by an average of 1 mm. Because the results of each vary considerably, their role in pre-operative planning require further studies.

Shortening Osteotomies

The Weil osteotomy starts 1-2 mm intra-articularly and runs parallel to the plantar aspect of the foot. Fixation is attained by means of a screw running perpendicular to the osteotomy line. Maceira[23-25] modified the osteotomy so that it starts extra-articularly and is coaxial to the bone, preserving the articular surface. The second cut is oblique and removes a piece of bone dorsally that indicates the amount of the planned shortening. The third cut is at the edge, starting where the second cut was, and is made parallel to the first cut (Figure 3).

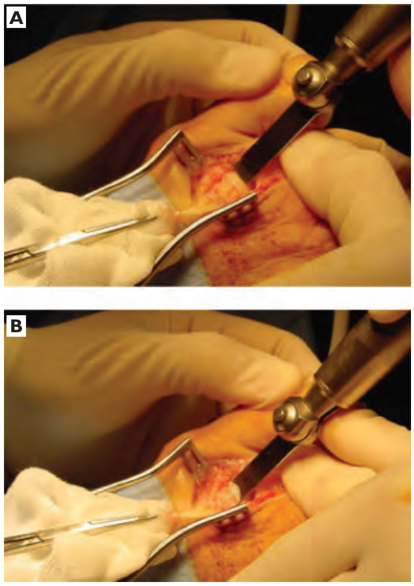

Figure 4: Weil Osteotomy (A and B) Note the intra-articular placement of the osteotomy, 1 or 2 mm inferior to the dorsal cartilage of the metatarsal head. The saw blade inclination is as much parallel as possible to the weight-bearing surface.

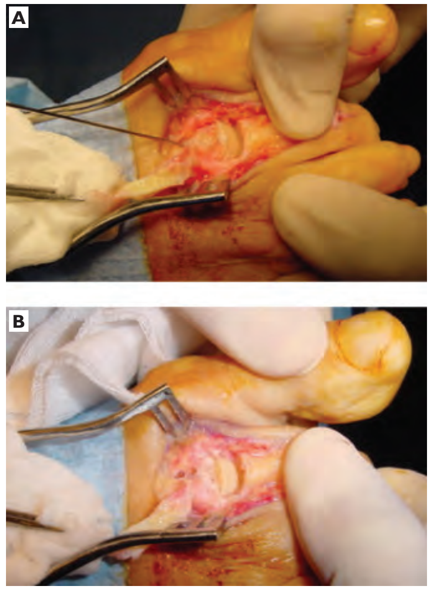

Figure 5: Fixation of the osteotomy. (A) Temporary K-wire prior to insertion of the final fixation. (B) Final fixation of the osteotomy; in this particular case, 2 absorbable Kirschner wires were used. The edge of the dorsal fragment has been removed.

Complications include stiffness, floating toe, recurrence, transfer metatarsalgia, non-union, and delayed and mal-union. Hoffstaetter[25,26] reports 88% good results for three Weil osteotomies with an eight-year follow-up. The Weil osteotomy is an effective and safe procedure for the treatment of third rocker/propulsive metatarsalgia. The triple Weil variation is promising and further studies and follow-up are needed in order to assess its efficacy as compared to the traditional Weil osteotomy (Figures 4, Figure 5).

Proper understanding of the root cause of metatarsalgia aids in developing a proper treatment plan for this condition. **PM**

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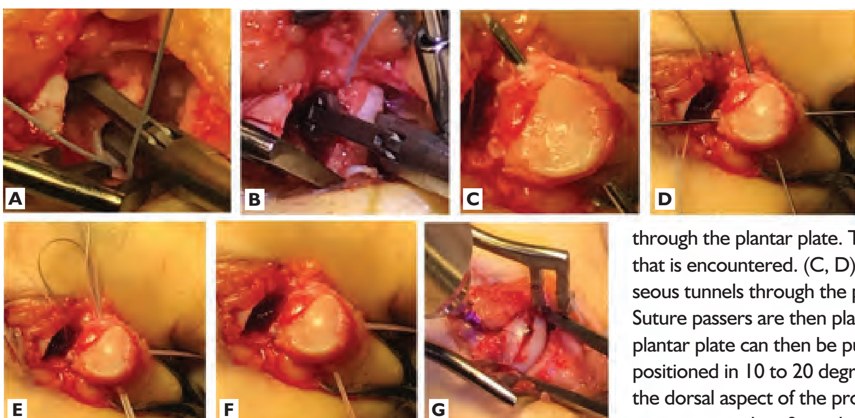

Figure 6: Weil metatarsal osteotomy with concomitant repair of the plantar plate using a single dorsal incision. Once the osteotomy has been performed and the second metatarsal head is retracted to allow for visualization and inspection of the plantar plate, the plate is transected (released) from the base of the proximal phalanx. (A, B) The Mini Scorpion is used to pass sutures through the plantar plate. The configuration of suture is dependent on the tear that is encountered. (C, D) Kirschner wires are then used to create crossed osseous tunnels through the proximal metaphysis of the proximal phalanx. (E, F) Suture passers are then placed through these tunnels and the suture from the plantar plate can then be pulled through the osseous tunnels. The toe is then positioned in 10 to 20 degrees of plantarflexion and the sutures tied down onto the dorsal aspect of the proximal phalanx to maintain correction. (G) The Weil osteotomy is then fixated.

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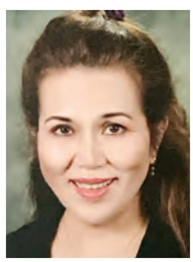

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