

Roundtable Discussion

Lesser Metatarsal Surgery

What are the common complaints of patients when they present to your clinic with lesser metatarsal problems?

Barouk: Metatarsalgia, callus, hammertoes, pain at the dorsal aspect of the metatarsophalangeal joint (MTP) joint, neuropathic pain.

Bohay: Most complaints center on the plantar foot at the lesser metatarsal heads. Patients will tell us they feel they are walking on "marbles" or a "balled-up sock" under their metatarsals. There may be concurrent deformity at the lesser toes (ie, hammertoes). They often have calluses under their metatarsal heads that will exacerbate their symptoms.

Trnka: Usually callosities under the metatarsal heads, pain around the MTP joints (MTPJs).

Weil: There are 2 types of conditions that I see from patients with lesser metatarsal complaints. Interestingly, 40 years ago in my practice, the primary complaint would have been an IPK under the second and third metatarsal. Today, the most common complaint is swelling and pain of the distal metatarsal, often associated with a hammertoe. I suspect that the reason has to do with the shoes "then," (high heels, pointed toes) and "now" (comfortable shoes such as athletic shoes and roomy casual shoes or sandals). In addition, iatrogenic metatarsalgia is often the complaint following a hallux valgus surgery, where the first metatarsal was either elevated or excessively shortened, causing a central metatarsal overload.

How do you assess these problems? What aspects of the physical examination are important to you?

Barouk: First, assessment of the gastrocnemius contracture. I search the localization of the pain: under a metatarsal head or on the intermetatarsal space. Mechanical or inflammatory pain, pain during stance phase or propulsive phase, MTP mobility, reducibility.

Weil: Typically, my routine is the same as with any condition, with an overall assessment of the structural and functional aspects of the foot, ankle, and lower leg. I focus on range of motion of the first MTP and the presence of moderate or severe hallux valgus; presence of a Morton's foot and hammertoe deformities; evaluation of motion, swelling, and pain on palpation of the distal metatarsal with comparison to the asymptomatic, contralateral foot; and finally, I evaluate the adjacent metatarsals for either similar complaints or potential complaints.

Trnka: I always take the foot in my hands; I examine the stability of the MTPJs, and I examine the web spaces. I look for Achilles tightness, instability TMT 1, hallux valgus deformity.

Bohay: The physical exam is the key to adapting the appropriate management scheme in patients presenting with metatarsalgia. When combined with a careful history, the correct diagnosis and treatment plan can be elucidated more than 90% of the time. Careful attention to

Each issue, we ask different practitioners how they treat a certain condition. In this month's "Roundtable Discussion," *Foot & Ankle Specialist* has assembled 4 international specialists with vast experience in the area of metatarsal surgery to discuss the topic of **lesser metatarsal surgery**, one of the most common problems that present to foot and ankle specialists. Over the years, many procedures have been used to solve these conditions with varying degree of success. Over the past 2 decades, some procedures have become more used and accepted around the world. However, there are still complications associated with these procedures when the world literature is reviewed.

CONTRIBUTORS

Pierre Barouk, MD

Clinique Saint Antoine de Padoue,
Bordeaux, France

Donald R. Bohay, MD

Director, Orthopedic Foot and Ankle Fellowship Program,
Orthopedic Associates of Michigan,
Grand Rapids, Michigan

Hans Jorg Trnka, MD

Foot and Ankle Center,
Vienna, Austria

Lowell Scott Weil Sr, DPM

Medical Director and Chief Executive Officer, Weil Foot & Ankle Institute,
Des Plaines, Illinois

the historical account of the symptoms and how they relate to weight bearing and shoe wear are important. How long have they had the symptoms? Do they have concomitant first-ray pathology (ie, bunion or lesser toe deformity, eg,

hammertoe)? Do they complain of any others symptoms that may be related to equinus contracture (ie, Achilles tendon pain, plantar fascitis, etc)?

On physical exam, we look to confirm their historical complaints by identifying pathological corollary. Attention to gait, vascular and neurological findings, skin condition, and so forth are important and completed very early in the exam. Looking for pathology at the first ray is critical and should include deformity, stability, and length. The patient with the unstable first ray will necessarily transfer weight to the lesser rays, which will act as a significant contributor to metatarsalgia. As the lesser toe MTPJ becomes overloaded and synovitis advances, there may be swelling at the MTPJ of the lesser metatarsals and in fact may be the predominate symptom early on. Finally, the capsule becomes insufficient and the intrinsic and extrinsic become unbalanced, and a hammertoe deformity may occur. If the patient has overly long lesser metatarsals (identified on radiograph by aberration of the normal metatarsal parabola), this overload phenomenon can be magnified. Gastrocnemius equinus contracture plays a significant role in the development of metatarsalgia. Physical exam includes a Silverskold test to identify the pathological condition. The Chopart joint is locked by the examiner and the knee extended. Ankle dorsiflexion with the knee extended and flexed should be equal. If it is not, then a gastrocnemius contracture is present by definition. This contribution to the patient's symptoms should not be underestimated and will need to be addressed as part of the overall solution.

What diagnostic tests do you use?

Weil: I focus on the sagittal plane stability of the symptomatic MTPJ by performing a "drawer test" with forced dorsal displacement of the second proximal phalanx. If this is positive, we order a magnetic resonance image (MRI) to confirm and/or "stage" (Weil Jr) a rupture of the plantar plate. I will test for neuroma with a Mulder maneuver (swelling under the joint could cause nerve compression, so I try not to be fooled into a nerve diagnosis unless a positive Mulders' is present

and confirmed by ultrasound or MRI in the second interspace). Of course, I evaluate for gastrocnemius equinus but do not consider that to be a significant cause in the average nonneuropathic patient. Evaluation of the AP radiograph is significant for relative metatarsal length pattern in the diagnosis of the origin of metatarsalgia. Comparison with the contralateral, asymptomatic foot will most often reveal a longer metatarsal overlying the symptomatic area. This can be as little as a couple of mm but it is very reproducible and consistent in the great majority of cases. In complicated cases, we use the Novel computerized foot pressure plate to gain a full assessment of the degree of pressure under the metahead and adjacent metaheads to plan surgery. We will also use the "DartFish" gait analysis to evaluate gait abnormalities that may contribute to this complicated case.

Bohay: Generally speaking, the only diagnostic study we use is a standing set of radiographs to include A/P, lateral, and oblique images. In certain circumstances, a T99 bone scan will be added to rule out stress fracture if the history and physical exam lead us away from the diagnosis of metatarsalgia. The use of MRI is rare and may be used in the workup for soft-tissue tumor, and so forth.

Trnka: Usually standing radiographs, only rarely MRI.

Barouk: X-ray, ultra sonography, MRI sometimes.

What are your differential diagnoses?

Barouk: Metatarsal over length, second-ray syndrome, Morton's neuroma, gastrocnemius tightness, stress fracture, cavus foot, decompensated hallux valgus.

Weil: I talk to the patient to understand where the actual pain is occurring in the ball of the foot. Is it dorsal (stress fracture)? Is it pain with joint motion (arthritis)? Pain when walking on a hard surface (metatarsalgia)? Pain worse with shoes (neuroma) or without shoes (metatarsalgia)?

Trnka: Instability in the MTP, ruptured plantar plate, Morton neuroma, fat pad atrophy.

Bohay: Differential diagnosis includes stress fracture, rheumatoid nodule, isolated gastrocnemius equinus, neuropathy, and so on.

What conservative care is used? How often does that work?

Trnka: Depending on the diagnosis, I have great results with taping in the situation of MTP instability and ruptured plantar plate (more than 70%), insoles, spiral dynamics physiotherapy (www.spiraldynamic.com).

Bohay: Conservative management generally centers on offloading the lesser metatarsals by virtue of a custom orthotic with metatarsal pad. Many patients find significant relief with this method and avoid a surgical procedure for the time being. We spend time with the patients to help them understand their problem from a mechanical standpoint and to educate them that their orthotic device is treating their symptoms but not the underlying pathology.

Weil: Conservative care is very effective in the acute, uncomplicated cases. Avoidance of high heels or flexible-sole shoes and use of a firm-soled shoe to stop the second metatarsal from "pole vaulting" thereby causing excessive load and time on the distal metatarsal. Patients are referred to our online store or a pharmacy for a cushioned insole and instructed to stop weight-bearing exercise for 2 to 3 weeks. In cases of significant foot malalignment, custom orthotics are considered for future use if the first line of care is unsuccessful. Complementary nonsteroidal anti-inflammatory drugs (NSAIDs) are always a good idea to break the pain cycle and allow for more normal ambulation. We never use cortisone injections in cases of metatarsalgia as we have collected more than 150 cases of dislocation of the MTP when a cortisone shot was administered (elsewhere) within 2 to 3 months of the patient's visit to our clinic.

Barouk: Orthotics, stretching, modification of shoe wear, pain killers, and NSAIDs, local infiltration.

What are the surgical procedures and fixation that you use?

Barouk: Metatarsal osteotomy: Weil fixed with a self-cutting screw; distal percutaneous osteotomy (DMMO) without fixation; BRT, which is a proximal elevation osteotomy of the metatarsal made at a 60° cut to the metatarsal fixed with a 2.5 screw; proximal gastrocnemius release.

Weil: There are a few components that must be considered when surgery is advised: (1) condition of the joint involved (arthritic or normal), (2) metatarsal relative length pattern as previously described, (3) presence of MTPJ contracture and hammertoe deformity, (4) instability or dislocation of MTP, and (5) collateral conditions such as hallux valgus, hallux rigidus, cavus foot, gastroc-soleus equinus.

The collateral conditions are repaired initially. The typical surgery for the elongated metatarsal would be the Weil metatarsal osteotomy (WMO), which is extremely effective for recalcitrant metatarsalgia without hammertoe. A 2- to 3-mm shortening has a high rate of success without complications. Multiple WMO procedures are performed only 20% of the time for central overload. When arthritis is present in the joint, I still favor a DuVries partial metatarsal arthroplasty removing a couple of millimeters of the distal metatarsal along with a plantar condylectomy. With forefoot cavus deformity, we use the Barouk-Rippstein base osteotomy to elevate the metatarsal, and this must usually be done on the central 3 metatarsals to avoid transfer of the load.

In cases of plantar plate disruption or frank dislocation, the WMO is performed with shortening of 4 to 6 mm and elevation (by removing a slice of bone) of 2 to 3 mm. In addition to the bone work, repair of the plantar plate using the technique as described by Weil Jr has been remarkably successful in achieving a relatively functional result as compared with other operations that we have used to correct significant deformities. After having tried virtually every fixation method for the WMO, we find

that the use of a 2.5-mm headless screw (MMI) provides the best fixation and lowest profile for this area where a screw head can be prominent after 1 year of swelling reduction.

Trnka: In case of dislocation in the sagittal plane, I use the Weil osteotomy with twist-off screws (Wright medical). In case of horizontal plane dislocation or subluxation (crossover toe), I use an extra-articular shortening and elevation osteotomy (like the Weil) fixed with 2.2 AO screws.

Bohay: Our surgical approach to the long metatarsal includes attending to each identified pathological entity at the time of surgery.

Technically, the metatarsal shortening is performed at the diaphysis of the metatarsal and either addressed through a separate dorsal incision or by utilizing an existing dorsal incision. The amount of metatarsal to be removed is decided from preoperative standing radiographs. Once the metatarsal is exposed and prior to the osteotomy, we place a 4-hole $\frac{1}{4}$ tubular plate over the desired metatarsal, and the distal 2 holes are predrilled with a 2.0-mm drill. The 2.7-mm screws are placed through the plate and removed. The osteotomy is then completed with a small oscillating saw. The distal cut is completed first, followed by the proximal cut to allow control of the metatarsal. Typically, the segment removed is approximately 5 mm. Once the osteotomy is completed, the plate is reapplied and secured distally, and compression is placed across the osteotomy while drilling and placing the proximal screws. Standard C-arm images are taken to confirm hardware placement and reduction. The osteotomy is then bone grafted with a small amount of local bone graft.

How do you accurately measure the change of metatarsal position intraoperatively?

Bohay: The change in metatarsal position is confirmed by C-arm imaging and direct visualization.

Barouk: With a ruler, I measure the length between metatarsals, to obtain the

formula 3/6/12 according to Maestro, for the Weil osteotomy and check at the fluoroscope. For the percutaneous, it is with the x-ray. For the BRT, it is the plantar palpation.

Weil: I actually use an intraoperative ruler to shorten the metatarsal exactly the distance that I have planned and based on the preoperative radiographs. I am careful to avoid shortening more than the adjacent metatarsal to avoid a transfer lesion, and if I do have to shorten more, I perform a WMO on the adjacent metatarsal.

Trnka: Palpation of the adjacent joint and a fluoroscope.

What technique tips for your surgery are most important?

Weil: The most frequent mistake that I see made by those using the WMO is an attempt to perform the procedure extra-articular. It is impossible to get even close to parallel when the procedure is performed from the dorsum. Therefore, I recommend an angle of 25° or as close to parallel to the floor, which will require beginning the osteotomy about 2 to 3 mm plantar to the top of the cartilage. The surgeon will get not only a shortening with a millimeter of elevation (saw cut) but also stability by using the dorsal ledge to prevent excessive elevation.

Barouk: For the Weil, exposure with a laminar spreader and remove a second layer of bone.

Trnka: If someone uses a Weil osteotomy, it is most important to use elevation (take out a slice).

Bohay: The osteotomy is by design straightforward and has a reliable union rate, as reported in our article "Midshaft Metatarsal Segmental Osteotomy With Open Reduction and Internal Fixation" (Galluch DB, Bohay DR, Anderson JG. *Foot and Ankle Int.* 2007;28(2):169-174). Rigid internal fixation with compression likely provides the most important technical tip for this operation.

Do you place a k-wire across the MTPJ? How often? What position? For how long?

Barouk: Never.

Trnka: Very rarely; if yes, for 3 weeks.

Weil: I have not used a k-wire across the joint in 20 years. I find that I can use $\frac{1}{2}$ -in. stretch SteriStrips to stabilize the toe without the complications of the joint crossing k-wire. This will also allow my patient to partial weight bear immediately.

Bohay: We will place k-wires across the lesser toe MTPJ when addressing lesser toe pathology primarily as it pertains to hammertoe deformity. If the MTPJ is unstable or difficult to reduce, we will place a 0.062 k-wire across the MTPJ while it transfixes the PIPJ, facilitating its fusion. We prefer the neutral position of the joint as confirmed by direct visualization and C-arm imaging. The k-wire is routinely removed in the office at 6 to 8 weeks postoperation.

What are the benefits and downsides of each procedure you use?

Bohay: The benefits of this technique are its simplicity, mechanical advantage, and success rate. However, in situations in which the practitioner is not comfortable with rigid internal fixation techniques, this could be a difficult procedure and thus render it less useful.

Weil: Within 2 years after I introduced the procedure in 1984, and after Barouk refined and popularized the procedure in Europe (and named it the Weil osteotomy), I reported the complication of a “floating toe” in cases that were associated with a significant hammertoe deformity. I recommended limiting shortening to 1 to 3 mm when possible, which seemed to lessen the problem, and also to perform early and vigorous physical therapy to strengthen the flexors to the toe and maintain plantar flexion range of motion. The benefits of the WMO are evident in the literature,

with numerous articles reporting generally very good results.

Barouk: For the Weil, large and controlled shortening, DMMO: no stiffness, BRT: precise, only 1 metatarsal should be addressed.

Trnka: The Weil osteotomy has the disadvantage of the floating toe and stiffness; the extra-articular osteotomy sometimes has healing problems.

How often do you need to surgically address concurrent hammertoe deformity with metatarsal problems? What is your preferred procedure for hammertoe in this situation?

Trnka: I see it very often, and I include a PIP fusion.

Barouk: Twenty-five percent of the time, I use PIP plantar release and k-wiring to stabilize, shortening proximal phalanx percutaneously, or PIP fusion.

Bohay: Anecdotally, lesser toe deformity in the form of hammertoes will need to be addressed approximately 50% of the time. In cases where the PIPJ is flexible, I prefer an extensor tendon lengthening with an MTPJ capsulorrhaphy and flexor to extensor tendon transfer. If the PIPJ is rigid, I will add a PIPJ arthrodesis with either k-wire fixation or intramedullary device (eg, Smart Toe [MMI]).

Weil: When a hammertoe is present, I fix it. Because of the shortening via the WMO, the hammertoe does not have to be shortened as much as when performed independently. I use arthroplasty, fusion, and Weil hammertoe implant depending on the deformity and the age of the patient.

How often to you consider plantar plate pathology in these problems?

Weil: I consider plantar plate repair *all* the time. Preoperative planning if I am sure of a disruption, and intraoperative

repair when I see a linear tear or disruption.

Trnka: I think for dorsal dislocation, the plantar plate is always involved.

Bohay: In cases in which the MTPJ is dislocated, there is no doubt that the plantar plate is disrupted. I have no experience with repair of the plantar plate in these situations.

Barouk: Ten percent of the time.

How often do you surgically address plantar plate pathology, and how do you perform that?

Trnka: I have not yet found a good technique. Caio Nery, MD, showed me something in Washington (at AOFAS) I may try.

Barouk: Two percent, with a dorsal approach, after a Weil osteotomy.

Weil: I always repair plantar plate pathology, except for the cases of metatarsal arthroplasty. As our learning curve has improved with the repair, so has our time (an extra 7-8 minutes) and results of the repair.

How do you surgically address dislocations of the MTPJ?

Barouk: Large shortening with the Weil osteotomy. But we have to harmonize the metatarsal parabola and so shorten the others.

Weil: I combine the plantar plate repair with a tendodesis of the plate into the base of the proximal phalanx using a fiberwire-type suture material. I usually incorporate the FDL tendon in that repair to gain stability of the MTP at the point of disruption.

Trnka: With the Weil osteotomy.

Bohay: MTPJ dislocations are essentially the endpoint of the deformity at the MTPJ in the cases of overload or, in the face of rheumatoid/psoriatic arthritis, the endpoint of synovitis/pannus and

joint destruction. Addressing the dislocation surgically is a must. We prefer to spare the metatarsal head, plantar plate, and thus the plantar windlass mechanism.

Generally, the MTPJ capsule is partially excised and the joint identified with traction on the toe. The collateral ligaments are released, and a McGlamry elevator or other similar instrument is used to release the scarred plantar plate and capsule. A concomitant metatarsal shortening as previously described can help with this joint relocation.

Do you believe that equinus contributes to metatarsal problems, and do you surgically address equinus concurrently with metatarsal surgery?

Barouk: Yes, I do the medial gastrocnemius proximal release; generally bilateral and 1 week before the foot surgery. This is a very easy and safe procedure. There's no immobilization, and it treats the cramps, the lower-limb instability, the lumbar pain, the difficulty to walk without a heel, and so forth. I do 1 or 2 a week.

Bohay: As previously discussed, it is paramount to address the equinus contracture at the time of reconstruction to decrease the plantar forefoot load. Assuming the patient has a gastrocnemius contracture, a gastrocnemius recession is performed at the same sitting. Obviously, if the physical exam finds that the contracture is by virtue of a tight Achilles, then that is addressed by a percutaneous Achilles tendon lengthening.

Trnka: I do not lengthen the Achilles, but I advocate stretching exercises.

Weil: Of course equinus has some influence on metatarsalgia, but in my opinion, it is not a significant causative factor unless the equinus is such that

one cannot even dorsiflex to 90°. If you lengthen the gastroc or Achilles, push off will be weakened, relieving the metatarsalgia. If the lengthening is performed without addressing the plantar plate pathology or even the elongated metatarsal, I opine that a significant number of patients will have a return of pain and keratosis within a couple of years.

What is the postoperative course for your metatarsal surgeries?

Trnka: Four (Weil osteotomy) to 6 (extra-articular osteotomy) weeks, a bunion shoe.

Weil: As with most of our forefoot surgeries (except for first MTP fusions) at the Weil Foot & Ankle Institute, we allow guarded weight bearing immediately. The postoperative dressing is very important to us, and we carefully align and stabilize all structures with ½-in. stretch SteriStrips and follow with a bulky compressive dressing. Cases are performed bilateral (when indicated), and the patients are seen 7 to 10 days after surgery when a comprehensive and aggressive physical therapy program is initiated using the Bioskin bracing system with the Weil osteotomy exercise straps during therapy and the Weil retention straps at night to maintain the toe in plantar flexion. This program, although in its infancy of only about 40 cases, has virtually reduced the floating toe to only 2 patients in this small pilot study. A multicenter study is now under way to evaluate this postoperative regimen.

Barouk: For the Weil and BRT, postoperative support heel shoe for 1 month; DMMO: flat rigid shoe.

Bohay: The postoperative treatment is usually dictated by concomitant procedures accompanying the metatarsal osteotomy. Generally, the metatarsal osteotomy is protected by partial weight bearing for 6 to 8 weeks.

Over the course of your career, how has your thought process on lesser metatarsal surgery evolved?

Bohay: The concepts outlined in this forum with regard to the mechanics and philosophy of lesser metatarsal overload and metatarsalgia have not changed much. The technical advancements of rigid internal fixation have helped make the osteotomy successful in 99% of the cases in our hands. The major advancement has been through the appreciation of the role gastrocnemius equinus contracture plays. Our understanding of the complexity of the foot and how we as surgeons intervene successfully continues to evolve.

Trnka: When I started, the Helal was the method for everything; in 1996, we started the Weil osteotomy. I have then tried several diaphyseal osteotomies.

Barouk: I avoid the stiffness given by the Weil by doing the DMMO, and I keep the Weil for the large shortening and dislocation. I do less metatarsal osteotomy since I discovered that the gastrocnemius can be a cause of metatarsalgia.

Weil: I was taught to perform the DuVries arthroplasty, and it actually produced a favorable result for IPK, early in my career. When Joe Addante, DPM, published his anecdotal experience of osteoclasis, it made a lot of sense to preserve the joint, and we (Steve Smith, DPM) developed the percutaneous metatarsal osteotomy to relieve these metatarsal conditions. Bob Hatcher and Bill Goller, our residents, published our results, which showed a transfer lesion rate of 40% when performed on a single metatarsal and 16% when performed on the central 3 metatarsals. Obviously, that was not so great, and I am deeply indebted to J. Barry Johnson, DPM, and Nathan Schwartz, DPM, who shared their thoughts and experience of propulsive phase metatarsalgia that led to the technique of the WMO. **FAS**