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Podiatry Today

Highlights from the 2019 American College of Foot and Ankle Surgeons Annual Scientific Conference

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CURRENT PERSPECTIVES ON FLATFOOT CORRECTION

Which surgical procedure is most effective for stage II flatfoot? How can surgeons best treat a rigid flatfoot deformity? When is a naviculocuneiform fusion appropriate? These expert panelists offered pearls on surgical procedure selection during the ACFAS flatfoot track.

By Brian McCurdy, Managing Editor

There has never been a consensus on when to treat posterior tibiotal tendon dysfunction surgically, according to Robert Mendicino, DPM, FACFAS. Over the decades, he notes treatments for flatfoot have moved from surgical to non-surgical. When does one operate on flatfoot and when will conservative treatments work?

As Michael Lee, DPM, FACFAS, notes, stage I flatfoot consists of mild tendon attenuation and no radiographic deformity is present. In stage I flatfoot, Dr. Mendicino notes the posterior tibial tendon is intact and inflamed with mild swelling. He says one should treat these patients with a controlled ankle motion (CAM) walker for two to four weeks, with custom or prefabricated orthoses, or with physical therapy if necessary. Dr. Mendicino notes operative treatment for stage I patients is uncommon but one may pursue surgery when pain and swelling do not resolve.

Stage II flatfoot involves attenuation or rupture of the posterior tibial tendon, notes Dr. Lee. He says this stage is mild to severe on radiographs but does not involve arthrosis. Dr. Mendicino notes stage IIA is flexible flatfoot, adding that these patients can perform a double toe raise but not a single toe raise. These patients can utilize CAM walkers, nonsteroidal anti-inflammatory drugs (NSAIDs) or get corticosteroid injections into symptomatic joints only. For stage IIA flatfoot, Dr. Mendicino says it is critical to address shoe gear and body mass index (BMI) to see if patients are willing to alter them.

As for bracing, Dr. Mendicino notes for patients with stages IIA and B flatfoot, he will use a hinged UCBL (University of California Biomechanics Laboratory) brace to provide stability, calling this a “Sherman tank around the ankle.” He notes patients may also perform posterior muscle stretching with an ankle foot orthotic (AFO), saying this will control pronation and avoid overstretching of the posterior tibial tendon. In six to 12 weeks, he has found that patients with stages IIA and B flatfoot are generally asymptomatic.

Dr. Lee says stage III is a severe flatfoot deformity with arthrosis. Dr. Mendicino notes these patients progress to forefoot abduction, rigid hindfoot valgus and degenerative joint disease in the subtalar joint.

Dr. Lee says stage IV flatfoot involves ankle valgus and arthrosis. When it comes to stage IVA flatfoot, Dr. Mendicino notes patients have a rigid forefoot with abduction, a rigid hindfoot and deltoid ligament insufficiency. Nonoperative treatment for these patients would include a rigid, molded AFO for a rigid deformity although the treatment would not be successful for a flexible deformity, according to Dr. Mendicino.

Surgical options for stage II flatfoot include an isolated tendon transfer, an isolated hindfoot arthrodesis, a reconstructive osteotomy and arthroereisis, notes Michael Lee, DPM, FACFAS.

What Are The Best Surgical Options For Stage II Flatfoot?
Surgical options for stage II flatfoot include an isolated tendon transfer, an isolated hindfoot arthrodesis, a reconstructive osteotomy and arthroereisis, notes Dr. Lee. He says surgeons would choose a procedure based on the degree of deformity, patient activity and expectations, the desired post-op course, surgeon preference and the BMI of the patient.
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In a survey of 104 surgeons, Hiller and Pinney noted a wide variety of approaches to stage II flatfoot. Dr. Lee notes 97 percent of surveyed surgeons would use some type of bony procedure, 88 percent would preserve the subtalar and talonavicular joints, 73 percent would perform a medializing calcaneal osteotomy, 41 percent would use lateral column lengthening, and 15 percent would perform medial column stabilization. Furthermore, 12 percent of surveyed surgeons would perform arthrodesis of one or more hindfoot joints, 98 percent would use a soft tissue procedure, 94 percent would augment the posterior tibial tendon, 53 percent would repair the spring ligament and 70 percent would address equinus with a posterior tendon lengthening.

When should surgeons perform arthrodesis for stage II flatfoot? Dr. Lee says fusion works well in patients with a higher BMI and older patients, and when one needs predictable results. He would fuse the subtalar joint in patients with severe hindfoot valgus and would fuse the talonavicular joint in older patients for whom he needs a definitive procedure. Dr. Lee adds that he almost never fuses the calcaneocuboid joint.

For patients with stage IIA flatfoot, Dr. Lee notes a medial slide osteotomy (percutaneous calcaneal displacement osteotomy), medializes the tuber and increases ground reactive forces. The osteotomy will correct heel valgus. He prefers two points of fixation.

Dr. Lee says a double calcaneal osteotomy is an excellent correction for late stage II flatfoot although he advises using caution laterally.

Medial column procedures for stage II flatfoot are almost always secondary with surgeons incorporating the procedures to correct the first ray and bring stability along the medial arch, notes Dr. Lee. Medial column procedures include naviculo-cuneiform joint fusion, a Cotton osteotomy and metatarsocuneiform joint fusion.

Dr. Lee notes ancillary procedures for stage II flatfoot include flexor digitorum longus transfers and spring ligament repair, procedures that are often dictated by the primary procedure.

Addressing The Rigid Deformities In Stage III And Stage IV Flatfoot

Stage III and IV flatfoot involve rigid deformity, notes Matthew Williams, DPM, FACFAS. He says one should address each plane of the deformity.

A triple arthrodesis is the traditional gold standard for rigid flatfoot, notes Matthew Williams, DPM, FACFAS. Here are preoperative and postoperative radiographs for a patient with flatfoot who had a triple arthrodesis.

Dr. Lee notes that ancillary procedures for stage II flatfoot include flexor digitorum longus transfers (see above) and spring ligament repair, procedures that are often dictated by the primary procedure.

However, Dr. Williams cautions that although triple arthrodesis can correct flatfoot, it may be at the expense of adja-
cent joints. Pell and colleagues reported the development of significantly more severe ankle arthritis after patients had a primary triple arthrodesis.5

If one is fusing two joints, Dr. Williams suggests a medial double arthrodesis involving the subtalar and talonavicular joints. He says this approach offers deformity correction in three planes and fewer soft tissue complications.

Berlet and coworkers found a medial double arthrodesis provided “excellent results” in correcting flatfoot in 20 patients.6 Sammarco and colleagues found arthrodesis of the subtalar and talonavicular joints in 14 patients with flatfoot provided improvements in pain, function and cosmesis.7 In a study of 31 flatfoot patients, Dr. Williams notes Steiner and colleagues found combining subtalar and naviculocuneiform joint fusion was effective for flatfoot with collapse of the medial arch at the level of the navicu-
locuneiform joint.8

Key Pearls On Medial Column Procedure Selection
Which patients with flatfoot benefit from naviculocuneiform fusion rather than a Cotton osteotomy? Troy Boffeli, DPM, FACFAS, says that many patient specific factors including age, condition of the posterior tibial tendon, activity level and BMI play a role in ideal procedure selection. Naviculocuneiform fault or arthritis are the main indications for naviculocuneiform fusion while a Cotton osteotomy is mainly for when there is no joint fault, hallux valgus or medial column degenerative joint disease. He notes fusion generally takes longer to provide improvements in pain, function and cosmesis. She notes fusion generally takes longer to provide improvements in pain, function and cosmesis.8 In a study of 31 flatfoot patients, Dr. Williams notes Steiner and colleagues found combining subtalar and naviculocuneiform joint fusion was effective for flatfoot with collapse of the medial arch at the level of the naviculocuneiform joint.8

In a review of 32 patients with flatfoot, Boffeli and Schnell found that after a Cotton osteotomy, all but one patient had radiographic evidence of graft incorporation at 10 weeks post-op, and the Meary’s angle improved by an average of 17.75 degrees.10

Soft tissue procedures are most effective around a structurally sound platform, emphasizes Lawrence Ford, DPM, FACFAS. He notes the efficacy of a gastrocnemius recession for flatfoot, citing a study by Rush and colleagues, who noted low morbidity in a study of 126 patients with flatfoot.11

Other options for tendon transfers include the flexor digitorum longus to the posterior tibial tendon, which Dr. Ford notes is relatively easy to do. He adds that transferring the flexor hallucis longus tendon to the posterior tibial tendon is a stronger repair but carries a greater cost to propulsive gait and is a more complicated harvest. Dr. Ford also advocates repairing the spring ligament if torn or attenuated, noting its location directly deep to the posterior tibial and flexor digitorum longus tendons.

References
NAVIGATING AND PREVENTING COMMON COMPLICATIONS WITH TAR

While total ankle replacement (TAR) can provide patients with better range of motion and improved quality of life, there are various complications that surgeons need to be cognizant of with these surgeries. Accordingly, leading surgeons at the ACFAS conference addressed risk factors and management of complications ranging from arthrofibrosis and infection to gutter impingement and talar subsidence.

By Brian McCurdy, Managing Editor

When deciding on ankle fusion versus ankle replacement, Christopher Hyer, DPM, FAFAS, notes that both procedures relieve pain and have year-long recoveries, but neither procedure is a final surgery for patients.

After TAR, patients feel almost immediate pain relief, according to Dr. Hyer. That said, patients want post-op motion and while a total ankle replacement (TAR) allows some motion, Dr. Hyer emphasizes that surgeons must manage patient expectations for post-op motion as the motion allowed will not be normal.

The ankle needs 20 to 25 degrees of motion for patients to walk without a limp, says Dr. Hyer. Although studies have shown TAR increases post-op motion, he notes such motion is clinically underwhelming. Coetzee and Castro noted a pre-op range of motion of 18.5 degrees in comparison to 23.4 degrees one year post-op. Lagaay and Schuberth, in a study of 95 patients who had a TAR, found patients maintained the initial range of motion at an average of 23 degrees at one year post-op.

When Patients With A TAR Experience Medial Malleolar Fracture

Medial malleolar fracture in TAR can occur due to factors such as limited surgeon expertise, poor operative technique, poor implant design or unsuitable instrumentation, according to James Cottom, DPM, FACFAS. He notes other reasons for fracture include limited visualization, implant oversizing, osteoporotic bone, improper implants and repeated pin placement.

Specifically, Dr. Cottom says in the early post-op period, medial malleolar fractures are due to factors such as improper bone resection, a weakened malleolus, prolonged immobilization, a loose implant, osteolysis, cysts or infection. Late post-op fractures, he notes, may be due to stress fractures, pathologic forces, malalignment or an unstable implant.

Dr. Cottom cites a classification system developed by Manegold and colleagues, who categorized TAR periprosthetic fractures by prevalence, location and possible cause, positing that their system can guide surgical decision making.

To prevent medial malleolar fracture, Dr. Cottom suggests defining syndesmosis and avoid making the cut too high. He says the best position for placement of an adjacent pin block is so the corner of the guide is located at the extension of the medial gutter.

Key Insights On Preventing Arthrofibrosis In TAR Cases

Dr. Hyer lists several intraoperative strategies to prevent arthrofibrosis in patients with TAR. He suggests not raising the
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joint line position as research into total knee replacements has shown raising the line can lead to decreased motion, decreased extensor strength and anterior pain. Dr. Hyer says thorough lavage should remove all bone debris and one should try to limit exposed, bleeding bone surfaces. He suggests the use of amniotic tissue and dexamethasone injection.

To control edema in the current postoperative period, Dr. Hyer advises having the patient wear a Jones splint for the first week and then wearing a non-weight-bearing cast for three weeks. At week four, he says patients should start physical therapy at home while wearing a boot, followed by formal physical therapy at week six. Patients should try to move to walking in a hinged ankle brace by week six to eight and Dr. Hyer also encourages aquatic exercises. In the long term, he says patients should move from an ankle brace to a graduated compression sock.

What are the nonoperative treatment options for arthrofibrosis? Dr. Hyer suggests a brisement-type local injection of lidocaine or saline as well as more physical therapy. As for surgical treatments, researchers have found success with joint manipulation under anesthesia with or without steroid injection for patients with arthrofibrosis following hallux valgus surgery. Dr. Hyer adds that authors have found arthroscopic debridement helpful for pain due to arthrofibrosis after TAR. Drug eluting scaffolds using celecoxib (Celebrex, Pfizer) and prophylactic treatments including intra-articular injections of montelukast, forskolin or triamcinolone may be future options for patients with arthrofibrosis, notes Dr. Hyer.

Identifying Potential Risk Factors For Infection
Deep infection is a high-grade TAR complication that researchers note will cause implant failure more than half the time, according to Thomas Roukis, DPM, PhD, FACFAS. Which TAR patients are at risk for infection? Dr. Roukis cites studies by Kesler, Patton and their respective colleagues noting that patients who have had previous ankle surgery, those with a low preoperative American Orthopaedic Foot and Ankle Society (AOFAS) hindfoot score, and patients who had a long operative time are at risk. He adds that patients with prolonged postoperative wound dehiscence or a secondary wound healing problem also have a risk of infection. Further research by Althoff and coworkers cites independent risk factors for infection such as age under 65 years, a body mass index under 19 kg/m² or over 30 kg/m², tobacco use, diabetes, inflammatory arthritis, peripheral vascular disease, chronic lung disease and hypothyroidism. Portillo and colleagues noted if ankle prosthetics fail within two years of implantation, it is highly predictive of infection.

Operating room conditions can also predispose patients to infection following TAR, notes Dr. Roukis. He cites studies noting that when OR doors open and close repeatedly during surgery, it can increase the risk of infection. Studies have also questioned the practice of surgeons wearing “space suits” in the OR, saying such suits did not reduce the risk of infection.

How can surgeons reduce the chance of infection during TAR surgery? Dr. Roukis suggests copious irrigation, limiting tourniquet time, limiting personnel in the OR and not repeatedly closing and opening OR doors during surgery.

What You Should Know About Anterior Wound Dehiscence
What are the risk factors for anterior wound dehiscence following TAR? Stephen Brigido, DPM, FACFAS, cites diabetes, corticosteroid use, inflammatory arthritis and female gender. Dr. Brigido points out several factors in
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TAR that can make incisions challenging. He says the need for exposure can make retraction difficult. Dr. Brigido emphasizes the importance of layered soft tissue closure, saying an exposed tendon with an open sheath will cause skin friction and opening. He adds that failed retinacular closure will cause wound dehiscence.

Dr. Brigido says placement of an 80 to 100 mm incision lateral to the midline will preserve the tibialis and the tendon sheath. One should proceed to mobilize the intermediate dorsal cutaneous nerve. He notes the surgeon should incise the retinaculum between the extensor digititorum longus and the extensor hallucis longus.

Then one should identify the neurovascular bundle, according to Dr. Brigido. He says the surgeon should incise the joint capsule straight to bone, retract the neurovascular bundle in the joint capsule and protect the neurovascular bundle throughout. Surgeons should perform appropriate dissection to visualize the medial and lateral gutters.

Then one should perform retinacular flap closure with thick, absorbable sutures to preserve the extensor tendon sheath and the tibialis anterior tendon sheath, suggests Dr. Brigido. He stresses the importance of using a subcutaneous stitch and suturing, not stapling, the skin.

**How To Address Gutter Impingement**

Gutter impingement is defined as impingement of a total ankle replacement or impingement of the medial and/or lateral malleolus, which limits range of motion and elicits pain and discomfort, notes Lawrence DiDomenico, DPM, FACFAS. He says medial and lateral pain are exacerbated by plantarflexion and dorsiflexion, and patients can experience subfibular pain and pain over the medial or lateral gutter. Dr. DiDomenico cautions that radiographs can be misleading when examining gutter impingement, noting that soft tissue impingement may not show up on X-rays.

The incidence of gutter impingement ranges from 2 to 23.5 percent and reportedly occurs with different implants, notes Dr. DiDomenico.25 Medial gutter impingement is more common than lateral. He says the condition has multifactorial causes, including technical errors, prosthetic design, residual gutter arthritis, oversized or undersized TAR components, ongoing instability, soft tissue impingements, ectopic bone formation or subsidence of the implant.

As part of the clinical evaluation for
gutter impingement, Dr. DiDomenico advises assessing the alignment of the foot and ankle as well as ankle and syndesmosis stability. Palpation can localize the center of pain. For this issue, he notes computed tomography (CT) scans are more accurate than X-rays or magnetic resonance imaging (MRI).

Progressive symptoms or patient dissatisfaction indicate surgery for gutter impingement, notes Dr. DiDomenico. He notes open and arthroscopic treatment are both effective although arthroscopy facilitates a quicker return to function and less soft tissue disruption. Dr. DiDomenico adds that prophylactic gutter resection can reduce the incidence of gutter impingement.

Current Perspectives On Talar Subsidence And Implant Loosening
Glazebrook and colleagues have noted subsidence is a medium grade TAR complication while Gail and colleagues attributed subsidence to a higher grade complication, notes Shannon Rush, DPM, FACFAS. He calls prosthetic loosening an “enigma,” advising diligent follow-up and early intervention.

While the exact mechanisms are not understood, periprosthetic bone cysts can lead to early TAR loosening and failure, says Dr. Rush. He emphasizes that contemporary TAR devices require osseous ingrowth for long-term stability but cautions that initial micromotion may lead to fibrous tissue ingrowth and the subsequent failure of fixation. Dr. Rush adds that incomplete osseous ingrowth leaves the potential for hydraulic osteolysis.

In regard to mechanical loosening of the implant, Dr. Rush cites factors including the role of cement, bone quality and the physical characteristics of the patient. He says loosening does not necessarily lead to implant migration and/or bone loss.

In a study of TAR implant loosening, Sopher and colleagues recommended that surgeons can achieve better primary stability by fixing closer to the joint line and not relying on a single peg with the authors noting that incomplete seating on the bone may lead to elevated implant-bone micromotion and strain. Es-

References
EMERGING INSIGHTS ON OPIOIDS, NSAIDS AND PAIN MANAGEMENT

Given the challenges of pain management in a time of escalating opioid abuse and overdoses, these ACFAS panelists discussed guidelines for safely prescribing opioids, pertinent screening techniques to prevent opioid abuse and non-opioid alternatives for pain relief.

By Brian McCurdy, Managing Editor

When should podiatric physicians prescribe opioids for chronic pain? Fred DeFrancesch, MD, lists several recommendations from the Centers for Disease Control and Prevention (CDC).

The CDC says non-pharmacologic and non-opioid pharmacologic treatments are preferable for chronic pain. Dr. DeFrancesch says clinicians should consider opioids only if the expected benefits for pain and function will outweigh the risks.

Before prescribing opioids for chronic pain, the CDC advises establishing treatment goals for patients and realistic goals for pain and function. Dr. DeFrancesch notes it may not be realistic for patients to be pain-free.

Before and periodically during opioid treatment, one should discuss the risks and benefits of opioids with patients. Dr. DeFrancesch says these include the risks of respiratory depression, difficulties operating motor vehicles and heavy machinery, interactions with other medications such as benzodiazepines, and the direct effects of opioids.

The long-term use of opioids often begins with the treatment of acute pain, notes Dr. DeFrancesch. He says when patients use opioids for acute pain, clinicians should prescribe the lowest effective dose of immediate-release opioids and in no greater quantity than needed for the expected duration of treatment.

Dr. DeFrancesch advises physicians to avoid utilizing methadone and transdermal fentanyl for these patients.

Before and during treatment with opioids, the CDC recommends evaluating risk factors for opioid-related harm. Dr. DeFrancesch says clinicians should develop a management plan to mitigate the risks.

Preventive Patient Screening Tips

In 2016, the CDC notes that more than 17,000 people in the United States died of prescription opioid overdoses. Allen Jacobs, DPM, FACFAS, notes that in the context of drugs, abuse is defined as using opioids in a non-medical matter while addiction implies a loss of control and an obsessive-compulsive pattern in patients.

Dr. Jacobs identifies some behaviors that may tip physicians off to manipulative behavior from those seeking opioids. He notes red flags include patients saying an opioid is the only thing that works for their pain and that non-opioids will not work. Opioid seekers may say they have a high tolerance for pain or always describe their pain as 10 out of 10 on the Visual Analogue Scale, according to Dr. Jacobs. He notes that some patients may ask for pain medication while they seem to be comfortable. Dr. Jacobs adds that other patients seeking opioids may have a dramatic response to pain when they are examined but are otherwise comfortable and laughing in the practice’s waiting room.

Other opioid-seeking behavior includes patients asking for opioids by name or saying they are allergic to non-opioids, notes Dr. Jacobs. He says some patients may say they are out of medication, have lost their medication or have lost their prescription. He adds that some drug seekers may look drowsy or forgetful.

Dr. Jacobs advises a basic screening for opioid-seeking behaviors, including ascertaining a history of drug and alcohol abuse. One should also screen for doctor

Here one can see a painful venous leg ulcer. Before prescribing opioids for chronic pain, the Centers for Disease Control and Prevention advise establishing treatment goals for patients and realistic goals for pain and function. Fred DeFrancesch, MD, notes it may not be realistic for patients to be pain-free.
shopping or drug-seeking behaviors. He adds that smoking is associated with a risk of opioid abuse and some patients may ask for opioids and then rapidly leave the office to go smoke outside.

Dr. Jacobs suggests that clinicians avoid prescribing potentially addicting substances but not withhold opioids for acute pain. He does advise against using opioids as an isolated therapy. Dr. Jacobs also says one should avoid any philosophical bias about drug issues and document one’s thought process in prescriptions.

A Closer Look At Alternatives To Opioids For Chronic Pain

What non-opioid treatments can physicians prescribe for chronic pain? Dr. DeFrancesch cites non-steroidal anti-inflammatory drugs (NSAIDs), cyclooxygenase-2 (COX-2) inhibitors, steroids, gabapentin (Neurontin, Pfizer), pregabalin (Lyrica, Pfizer), acetaminophen, selective serotonin reuptake inhibitors (SSRIs) and serotonin-norepinephrine reuptake inhibitors (SNRIs).

Dr. DeFrancesch says NSAIDs and COX-2 inhibitors are useful for nociceptive or neuropathic pain. Acetaminophen is also effective for nociceptive pain. He notes steroids are good for pain associated with rheumatoid arthritis or osteoarthritis, and may also be effective for gout or inflammatory joint disease.

Gabapentin and pregabalin are approved for diabetic peripheral neuropathy, notes Dr. DeFrancesch. He says SNRIs are effective for neuropathic pain, chronic musculoskeletal pain and fibromyalgia.

As for non-pharmacological options for chronic pain, Dr. DeFrancesch cites the use of radiofrequency nerve ablation, spinal cord stimulation, peripheral nerve blocks, epidural injections and sympathetic blockades. He adds that heat, ice, iontophoresis and phonophoresis are other chronic pain treatment options. Dr. DeFrancesch says physical therapy, particularly exercise therapy, aerobics and aquatics, can help reduce pain and improve function.

Do NSAIDs Affect Post-Op Union Rates?

Although multiple studies have investigated whether NSAID use can exacerbate non-union following surgery, Aksone Nouvong, DPM, FACFAS, notes the evidence is not entirely clear.

Citing a study of patients with diaphyseal fractures, Dr. Nouvong says 190 patients used NSAIDs and 182 patients used opioids postoperatively. The authors did not find a significant difference in healing between the two groups. In a retrospective analysis of 434 patients who used NSAIDs following spinal fusion surgery, Dr. Nouvong says the study authors found no significant negative effect on union after short-term perioperative administration of celecoxib (Celebrex, Pfizer), rofecoxib or low-dose ketorolac. In contrast, Dr. Nouvong says Jeffcoach and colleagues conducted a retrospective study of 1,901 patients who suffered fractures of the femur, tibia and/or humerus. Of those patients, 12.1 percent used NSAIDs and researchers found them twice as likely to experience non-union or malunion. Burd and coworkers, in a retrospective study of 282 patients who had open reduction and internal fixation for an acetabular fracture, found that post-op indomethacin (Tivorbex, Iroko Pharmaceuticals) posed a higher risk of non-union.

Dr. Nouvong advises patients not use NSAIDs for more than seven to 14 days. She suggests stopping NSAID use if there is evidence of delays in union.

References

When patients have Charcot neuroarthropathy, deformity leads to pressure, ulceration and infection, notes Andrew Meyr, DPM, FACFAS. He says one may suspect Charcot neuroarthropathy when the patient presents with a foot that is red, hot, swollen and neuropathic. Then one would confirm the diagnosis with radiographic evidence of fragmentation and dislocation.

Dr. Meyr describes a diagnostic algorithm for Charcot that includes assessing skin temperature, edema, subjective pain and the clinical appearance of the foot.

For temperature monitoring, Dr. Meyr suggests using consistent anatomic locations on the foot, taking the mean of multiple measurements. Van Netten and colleagues found the most optimal cutoff skin temperature for detecting complications in the diabetic foot to be 2.2°C between contralateral spots. Dr. Meyr notes technologies to assess skin temperature include infrared thermography, socks, insoles and floor mats.

To assess peripheral edema in patients with suspected Charcot, Dr. Meyr advises measuring the circumference of the extremity at consistent anatomic locations. He suggests doing serial measurements to compare the foot with suspected Charcot with the contralateral extremity.

As for assessing subjective pain, Dr. Meyr notes misconceptions about diabetic sensorimotor neuropathy that primarily affects A delta fibers and C fibers. He adds that patients may relate a history of trauma or an inciting event.

Dr. Meyr says the clinical appearance of a Charcot foot may include a rocker bottom deformity. He says pre-ulcerative and wound locations are fairly pathognomonic. During the physical exam, he suggests deep palpation of the medial and lateral plantar midfoot. Advanced imaging modalities include magnetic resonance imaging (MRI), computed tomography (CT) scans and bone scans. Dr. Meyr says imaging will reveal early fragmentation and dislocation that are not visible on radiographs, bone edema, stress fracture lines and osseous viability.

Is there clinical value in reaching an early diagnosis of Charcot? Dr. Meyr cites a study by Pinzur and colleagues of nine patients with stage 1 Charcot without wounds and with minimal deformity, noting all patients had uneventful consolidation of their acute symptoms with the use of total contact casts. In a study of 24 patients with Charcot, one of 11 patients who had an early diagnosis went on to have joint fragmentation and deformity.

By Brian McCurdy, Managing Editor
while 12 of 13 patients with a late diagnosis experienced joint fragmentation and deformity.\textsuperscript{6} Wukich and coworkers found of 22 patients with Charcot, seven did not progress to joint fragmentation with a mean referral of 4.1 weeks while 15 patients did progress to joint fragmentation with a mean referral of 8.7 weeks.\textsuperscript{7} However, Dr. Meyr points out that those types of studies are at risk for “type I errors” or false positives.

If there is an early misdiagnosis of Charcot, Dr. Meyr cites several studies noting complications with Charcot patients using total contact casts.\textsuperscript{8-10} Although early diagnosis and intervention are important, Dr. Meyr notes clinical, radiographic and laboratory diagnostic criteria have not yet been established. He says radiographic evaluation of joint fragmentation and dislocation should extend beyond classification systems and radiographic measurements.

### Key Pointers On Diagnostic Markers For Charcot

Several inflammatory biomarkers can indicate Charcot neuroarthropathy, according to Javier La Fontaine, DPM, FACFAS. Physiologic markers include the receptor activator of nuclear factor kappa-B ligand/osteonectin (RANKL/OPG) axis, inflammatory cytokines, the receptor for advanced glycation end products (AGE/RAGE) pathway, endothelial nitric oxide and calcitonin gene-related peptide (CGRP). He cites clinical markers such as C-reactive protein and the erythrocyte sedimentation rate.

Jirkovska and colleagues showed an association between decreased mineralization and Charcot.\textsuperscript{11} Dr. La Fontaine notes that researchers also found patients with acute Charcot had significantly lower stiffness in the calcaneus and lower bone mineral density in the lower femoral neck bone.

Dr. La Fontaine notes the presence of 316-amino acid transmembrane protein expressed by T cells in trabecular bone. He says RANKL binds on monocyte/macrophage lineage cells, including osteoclasts, dendritic cells and their precursors. He adds that OPG is a decoy receptor for RANK that inhibits osteoclastogenesis.

Dr. La Fontaine cites research showing a strong association among Charcot, osteopenia, neuropathy and vascular calcification, specifically that 90 percent of patients with Charcot have vascular calcification on plain X-rays.\textsuperscript{12-15}

As Dr. La Fontaine notes, excessive bone resorption in Charcot neuroarthropathy could potentially be linked to increases in circulating osteoclast precursors and serum levels of tumor necrosis factor-α (TNF-α).\textsuperscript{16} Petrova and coworkers, in a study of 35 patients with Charcot, found serum concentrations of TNF-α and interleukin-6 (IL-6) were raised at the onset of Charcot, but both markers were decreased at the resolution of Charcot.\textsuperscript{17} Folestad and colleagues found that IL-17 cytokines and TNF-α increased quickly after offloading in patients with Charcot, and attributed these increases to the immobilization and stabilization of the Charcot foot.\textsuperscript{18,19}

Witzke and colleagues found patients with Charcot had significantly decreased circulating soluble RAGE along with an increase in serum markers of bone turnover.\textsuperscript{20} Dr. La Fontaine adds that patients had less calcaneal bone stiffness that researchers note was not accompanied by decreased bone mineral density.

Dr. La Fontaine says research suggests that abnormal calcitonin gene-related peptides and abnormal nitric oxide synthase activity may be factors in the development of Charcot.\textsuperscript{21}

Calcitonin gene-related peptide is a sensory neuropeptide that induces vasorelaxation in the endothelium, according to Dr. La Fontaine.\textsuperscript{22,23} He notes CGRP is present in unmyelinated C-type fibers and small myelinated A-type fibers, and is abundant in the periosteum, bone marrow and epiphysis. This peptide modifies osteoblast activity by increasing the production of IGF-1, IGF-2 and IL-6, and inhibits bone resorption through direct action on osteoclasts. Dr. La Fontaine adds that the ablation of CGRP results in osteopenia due to reduced osteoblast formation.

Dr. La Fontaine adds that there is no evidence to support C-reactive protein assisting in the diagnosis of acute Charcot foot as C-reactive protein is associated with infection and tissue necrosis.\textsuperscript{20} Dr. La Fontaine notes that inflammatory markers are elevated in acute Charcot foot and vascular calcification may be a risk factor for complications. He adds that neuropathy may have a direct effect in bone healing, possibly through RANKL-CGRP.

### Essential Considerations For Surgical Treatment Of Charcot Neuroarthropathy

The goal when treating Charcot neuroarthropathy is to attain a foot that is plantigrade, free of ulcers and braceable, notes Katherine Raspovic, DPM, FACFAS. She notes the talo-first metatarsal angle should be as close to 0 degrees as possible on AP and lateral radiographs.

Dr. Raspovic emphasizes the importance of understanding the indications for surgery, which include a foot and ankle that are not plantigrade, or a foot that cannot be braced as well as the presence of pre-ulcerative lesions, recurrent ulcers, non-healing ulcers, pain, instability and infection. She suggests a preoperative “checklist” for Charcot focusing on areas such as vascular assessment, glycemic control, vitamin D and nutritional status.

Wukich and colleagues compared the
head allografts with retrograde intramedullary nails.

Stabilize the ankle and hindfoot temporarily while realigning the midfoot.

Dr. Raspovic discusses the use of a “joystick” in the calcaneus to restore calcaneal inclination.

For midfoot Charcot (shown here), Katherine Raspovic, DPM, FACFAS, discusses techniques for reconstruction including realignment arthrodesis of the medial and lateral columns as well as biplanar/wedge osteotomies. She cites the use of a “joystick” in the calcaneus to restore calcaneal inclination.

Moore and coworkers found those patients with diabetes developed a tibial stress fracture.

Can a longer intramedullary nail prevent fractures? Dr. Raspovic says Noonan and colleagues compared a 150 mm nail with nails that terminated in the proximal metaphysis for tibiotalocalcaneal arthrodesis, and found a shorter nail increased the stress concentration at proximal screw holes.

In a study of 45 patients who had tibiotalocalcaneal arthrodesis for Charcot, Caravaggi and colleagues found at a mean follow-up of five years, 86 percent had returned to independent ambulation.

Dr. Raspovic adds that Ettinger and coworkers, in a study of 12 patients who had tibiocalcaneal arthrodesis for Charcot, found that 91 percent were ambulating independently at a mean 18-month follow-up.

Wukich and colleagues, in a study of 2,060 patients both with and without diabetic neuropathy, found peripheral neuropathy and a HbA1c level of >8% were independently associated with surgical site infections.

Dr. Raspovic says Noonan and colleagues compared a 150 mm nail with nails that terminated in the proximal metaphysis for tibiotalocalcaneal arthrodesis, and found a shorter nail increased the stress concentration at proximal screw holes.

He says ex-fix allows the distribution of body weight away from diseased bone and is one of the few ways of enforcing patient adherence.

For internal fixation, Dr. Steinberg says options include superconstructs, locking plates, plantar plates, axial screws, beaming, and intramedullary nails.

What Studies Reveal About Charcot Fixation Options

For patients with Charcot, John Steinberg, DPM, FACFAS, says external fixation is appropriate for patients with open wounds. He says ex fix allows the distribution of body weight away from diseased bone and is one of the few ways of enforcing patient adherence.

A study by Kroin and coworkers found Charcot surgery improved quality of life in 25 patients with midtarsal Charcot.

Dr. Raspovic notes the authors indicated a shift in the treatment of Charcot away from immobilization during the active phase and accommodation of the deformity toward surgical correction to let patients wear therapeutic footwear. She adds that realignment arthrodesis may be more successful if one performs it before the Charcot deformity advances.

When surgically treating Charcot neuropathic foot deformity, Lawrence DiDomenico, DPM, FACFAS, emphasizes the need for going slowly, using Charcot staging and having an aggressive infectious disease team. As he notes, Burns and Monaco argued that when Charcot surgery fails and the surgeon is planning revision, relevant factors include nutrition, vascular status, infection control, and the management of blood glucose.

The authors noted four patients with diabetes with HbA1c concentrations at proximal screw holes.

Domek and colleagues found a 5 percent increase in HbA1c independently associated with surgical site infection and non-union for Charcot.

What Studies Reveal About Charcot Fixation Options

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Grant and colleagues studied beaming in 71 patients with Charcot. The authors noted patients showed improvements in Meary’s angle, the calcaneal inclination angle, the tarsometatarsal angle, the talonavicular angle and the calcaneocuboid angle.

Dr. Steinberg notes Hegezwal and colleagues studied the combination of internal and external fixation in 22 patients with Charcot. During a mean 58-week follow-up, the authors noted 20 patients achieved limb salvage.

Dr. DiDomencio notes Sammarco explored the concept of superconstructs to enhance fixation, extending fusion beyond the zone of injury into unaffected joints. The author notes bone resection permits the adequate reduction of the deformity without undue tension on the soft tissue envelope.

References

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When complications arise following lesser ray surgery

Whether it is addressing transfer metatarsalgia, flail toe or elevated toes, these ACFAS panelists shared insights on managing common post-op complications from lesser ray surgery.

By Brian McCurdy, Managing Editor

When hammertoe procedures fail, Thomas Chang, DPM, FACFAS, notes potential sources of failure can include adjacent non-fixated arthroplasties, failed digital/first metatarsophalangeal joint (MPJ) implants, scarring or soft tissue contractures. Dr. Chang advocates a systemic approach to hammertoe correction that takes into account the biomechanical alignment of the foot. He notes the goals with correcting hammertoe complications include balancing metatarsal loading, establishing a functional MPJ and providing flexor power to stable digits. Oftentimes, cosmesis is a secondary concern.

“Instead of just focusing on the toe that is crooked, the surgeon needs to take a step back and really look at the whole mechanical alignment of the forefoot and build a solid foundation,” says Dr. Chang.

Often, Dr. Chang notes the surgeon may need to address the hindfoot and ankle for long-term success. Then they can logically approach the forefoot from proximal to distal.

“This will include balancing the metatarsal parabola first and then finally, the toes can be stabilized for more successful long-term outcomes,” says Dr. Chang. “It is all based on our understanding of sound biomechanical principles.”

To restore motor function, Dr. Chang says surgeons may find success with a proximal interphalangeal joint arthrodesis or an interphalangeal joint fusion.

At times, Dr. Chang says metatarsal length will be the issue in the parabola imbalance. Shortening osteotomies or even bone graft techniques can facilitate structural rebalancing and result in better alignment to the MPJ. He says to establish a functional MPJ, toes should be rectus and the cartilage should ideally be aligned in a forward direction, noting this may require distal head osteotomies at times.

To restore motor function to the joint, Dr. Chang says surgeons may find success with a proximal interphalangeal joint arthrodesis or a flexor tendon transfer. In certain cases, he says one can perform both procedures together.

If multiple rays are out of balance in the patient with clinical hammertoe deformities and there are more bad rays than good, Dr. Chang says surgeons can also reset the parabola with a pan-metatarsal head resection approach. This is rarely the approach taken, but he says it should be a consideration in severe forefoot deformities.

**When The Toe Is Elevated Following Plantar Plate Repair**

When repairing the plantar plate, Michael Theodoulou, DPM, FACFAS, emphasizes distinguishing between ideal and realistic goals of repair. He notes ideal biomechanical goals consist of restoring the static strength of the plantar plate to allow the toe to position itself anatomically in all cardinal planes of the body. This will permit the dynamic stabilizers to maintain alignment and allow for active purchase of the toe on the weightbearing surface. However, Dr. Theodoulou emphasizes realistic repair goals that take into account patient expectations, including appropriate alignment of the toe between the hallux and third toe with the ability to purchase the ground when standing with normal pliability.

Dr. Theodoulou notes the plantar plate can be challenging to repair due to its anatomy, tissue properties, biomechanics and extrinsic factors such as environment and postural deficits of the foot.

To avoid a toe that will not touch the ground, Dr. Theodoulou advises keeping the McGlamry elevator in line with the metatarsal shaft and refrain from releasing the accessory collateral ligament from the metatarsal head. He says one should also make the osteotomy as close to parallel to the weight-bearing surface as possible to minimize plantarflexion of the metatarsal head and dorsal translation of the metatarsal axis.

In a study of 54 patients who had received surgical correction for lesser MPJ imbalances due to complex hammertoes, Cook and colleagues found anatomic plantar plate reconstruction provided digital stability and radiographic alignment.

Dr. Theodoulou advises correcting hammertoe with an interphalangeal arthroplasty or arthrodesis. He notes surgeons should perform a distal second metatarsal osteotomy to repair the plantar plate with potential medial translation. Dr. Theodoulou also suggests augmenting sutures or tape when repairing the plantar plate.
Bouché and Heit studied 20 patients with severe, chronic sagittal plane instability in the lesser MPJs. Dr. Theodoulou notes the authors found that combining plantar plate and hammette repair with a flexor digitorum longus tendon transfer successfully addressed the patients’ instability and deformity.

In a retrospective review of 31 patients who had hammertoe and instability, Dr. Theodoulou says Joseph and colleagues found lesser MPJ fusions provided patients with less pain and better digital alignment.

Dr. Theodoulou advises surgeons to appreciate associated deformities and address first ray insufficiency and long second metatarsals. He says one should also appreciate overall patient health and consider factors that may contribute to poor connective tissue, such as age or connective tissue disease. If there is no reconstructible plantar plate or collateral ligaments, Dr. Theodoulou says surgeons must consider tendon transfer or connective tissue augmentation with sutures or tape.

**When Patients Have Flail Toe**
Flail toes lack stability and structural integrity, says Michelle Butterworth, DPM, FACFAS. She says the condition may result from excessive bone resection or tendon over-lengthening.

Dr. Butterworth notes treatment options for flail toe include implant arthrodesis, syndactyly, bone graft stabilization and amputation. She says amputation is viable in select patients, such as older patients, those with poor tissue, those with no cosmetic concerns and when the flail toe is the fifth toe. Dr. Butterworth says one should use implants when patients have good bone stock.

Mahan presented a case study of bone graft stabilization for a flail toe, noting the procedure was a success at 18 months’ follow-up. Dr. Butterworth says the goals of bone graft stabilization are restoring stability, improving the digital parabola, improving flexor tendon strength and stability, and improving cosmesis.

Dr. Butterworth says with bone grafts, the surgical technique includes debriding to healthy bone and adding bone to restore length. She says one should use autologous bone due to its healing potential and use bone with enough cortical strength to resist compression. Dr. Butterworth uses a 0.045-inch K-wire for stability across the MPJ.

Postoperatively, Dr. Butterworth says patients use a non-weightbearing cast for eight weeks. She notes complications of bone grafts can include non-union, residual deformity, tissue loss, graft collapse, donor site complications and infection.

**Key Pearls On Treating Transfer Metatarsalgia**
When treating transfer metatarsalgia, Michael Downey, DPM, FACFAS, stresses determining whether the patient has hallux valgus or hammertoe. He also suggests determining if the extensor tendon is constrained.

For preoperative planning for metatarsalgia procedures, Dr. Downey emphasizes the concept of the Maestro line. This refers to the line passing from the center of the fibular sesamoid, perpendicular to the longitudinal bisection of the second metatarsal, and through the fourth metatarsal head.

Ali and colleagues found the Maestro technique has high intra-rater and inter-rater reliability, and is suitable for use for operative planning. However, Chauhan and coworkers found that the Maestro method produces different measurement results than the methods of Coughlin, and Hardy and Clapham, and questioned the use of the Maestro method in preoperative planning.

In an analysis of 1,131 Weil osteotomies, Dr. Downey notes Highlander and coworkers found 7 percent of patients had transfer metatarsalgia. Devos Bevernage and Leemrijse reviewed 63 patients who had Weil osteotomies to treat persistent metatarsalgia and restore an ideal foot morphology based on Maestro’s theory. Dr. Downey notes that after surgery, 15 percent of the patients still had metatarsalgia. The authors noted the difficulty of attaining an ideal foot type, saying there was a significant relationship between preoperative instability and the risk of transfer metatarsalgia.

**What Studies Say About Preventing Malunion And Nonunion With Lesser Metatarsal Osteotomies**
Why do malunion and nonunion occur following lesser metatarsal osteotomies? Than Dinç, DPM, FACFAS, cites factors such as an unstable osteotomy, inadequate fixation, treatment failure and host factors.

To prevent malunion and nonunion, Dr. Dinç advises starting with a stable osteotomy, noting she performs a modified Weil osteotomy that allows for shortening of the metatarsal without further plantarflexion of the metatarsal head. Additionally, she says the osteotomy, involving two parallel cuts in a distal-dorsal to plantar-proximal direction, is an inherently stable construct with added security with the addition of screw fixation.

Dr. Dinç says the traditional Weil osteotomy has proven to be a reliable procedure for metatarsalgia as evidenced by a seven-year follow-up study, in which Hofstaetter and colleagues found a Weil osteotomy was safe and effective for metatarsalgia and subluxed or dislocated MPJs, with the authors citing excellent results in 22 of 24 patients. She adds that modification of the osteotomy with the addition of coronal plane correction also showed good functional results and patient satisfaction for crossover toe at a mean 10 month follow-up.

**References**

NAVIGATING SECOND MPJ INJURIES: KEYS TO ASSESSMENT AND TREATMENT

*Emphasizing their approach to addressing plantar plate injuries, panelists at the ACFAS conference discussed the possible etiologies of second MPJ injuries, offered diagnostic insights and assessed current treatment options.*

By Brian McCurdy, Managing Editor

Injury to the plantar plate leads to an interruption of the windlass mechanism, which leads to instability, says Lawrence Ford, DPM, FACFAS. As he notes, plantar plate injuries can include frank ruptures, tears or attenuation. He says most plantar plate injuries are chronic and due to repetitive microtrauma.

Dr. Ford emphasizes that plantar plate injuries may not solely be attributed to the second toe but can be caused by a dysfunctional forefoot. He advises addressing the underlying causes before deciding on surgical or nonsurgical treatment of the plantar plate.

Patients with plantar plate tears often experience pain, swelling and progressive toe deformity, notes Katherine Dux, DPM, FACFAS. She adds that patients may also have vague pain in the second interspace or pain on end range plantarflexion of the lesser MPJs. Dr. Dux says prior incorrect diagnoses of plantar plate tears may include neuromas with failed treatments.

Klein and colleagues noted, in a study of 90 patients with plantar plate tears, that 95 percent of patients presented with a gradual onset of forefoot pain, edema and a positive drawer test, notes Dr. Dux. She adds that patients with plantar plate injuries may also have vague pain in the second interspace and pain on the end range of plantarflexion.

With the exception of direct trauma, Matthew Sorensen, DPM, FACFAS, notes injury to the second metatarsophalangeal joint (MPJ) is not a normal scenario. Therefore, he says a structural or biomechanical problem is most likely the cause. Simply treating pain in the second MPJ will fail, he emphasizes. The plantar plate is the major stabilizing structure of the lesser MPJs, according to Dr. Sorensen. He says chronic overload leads to attenuation or elongation of the plantar aponeurosis.

In a review of the radiographs of 88 patients, Klein and colleagues noted patients with plantar plate tears exhibited increased digital splay in comparison to those without plantar plate tears. The authors noted patients with an intermetatarsal angle of more than 12 degrees, medial deviation of the second toe and splayed digits had higher odds of an intraoperative diagnosis of plantar plate tears. Dru adds that radiographs may reveal that patients with plantar plate tears have abnormal metatarsal parabolas, increased intermetatarsal angles and medial deviation of the second digit.

What are the most effective diagnostic tools for plantar plate tears? Dr. Dux says Donegan and coworkers found high-resolution dynamic ultrasonography to be more accurate than magnetic resonance imaging (MRI) in diagnosing plantar plate pathology, but the authors noted the difference between the two modalities was not statistically significant.

The plantar plate is also involved in crossover second toe, notes Dr. Sorensen. He cites a study by Deland and Sung, who found that crossover second toe involves medial displacement of the flexor tendons and plantar plate along with plantar plate deformity, medial collateral ligament contracture and lateral collateral ligament rupture.

A study by Kaz and Coughlin focused on the common clinical presentation of a plantar plate injury. Patients with plantar plate tears often experience pain, swelling, and progressive toe deformity, notes Kathleen Dux, DPM, FACFAS.

Here is a post-op photo after a flexor digitorum longus tendon transfer. Lawrence DiDomenico, DPM, FACFAS, notes several advantages of this procedure for the second MPJ.
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on 169 patients with crossover second toe. Dr. Sorensen says the authors noted patients had an increased incidence of both hallux valgus and degenerative arthritis in the first MPJ, and adds that crossover second toe was more common in women over 50.

**A Closer Look At Surgical Options For Plantar Plate Injuries**

A second metatarsal osteotomy allows surgeons access to the plantar plate and collateral ligaments, according Dr. Sorensen. He says performing a joint decompression osteotomy relegates chronically contracted soft tissues to physiologic tension. Dr. Sorensen cautions against overshortening in a metatarsal osteotomy.

Dr. Sorensen cites a study by Coughlin and colleagues focusing on 136 interdigital neuromas in 121 patients. The authors noted that at a four-year follow-up, resection of the interdigital neuroma led to a stable second MPJ.

As part of the direct plantar approach, Dr. Ford suggests supine patient positioning. Employing sharp dissection and a diagonal approach, the surgeon would make a plantar incision between the metatarsal heads. He says one dissects the plantar plate insertion off the proximal phalanx. Then create a U-shaped flap and anchor the flap to the proximal phalanx. Dr. Ford adds this may require concomitant hammertoe correction or a metatarsal shortening osteotomy.

Postoperatively, Dr. Ford says patients are non-weightbearing for four weeks, transition to a controlled ankle motion (CAM) walker for two weeks and then advance to firm shoes with a metatarsal “cookie.”

Complications with a direct plantar approach may include a palpable scar or knot, vascular embarrassment, overcorrection, undercorrection or recurrence, according to Dr. Ford.

Lawrence DiDomenico, DPM, FACFAS, notes several advantages of tendon transfers, which include a flexor digito-

rum longus tendon transfer and an extensor digitorum brevis transfer into the extensor digitorum longus tendon for the second MPJ. He says these benefits include leaving the metatarsal, the proximal interphalangeal joint and the distal interphalangeal joint intact, and letting the toe purchase the ground.

Additional benefits to extensor and flexor tendon transfers include better cosmesis, minimal edema, no loss of cubic volume of bone that might create instability, and no need for implants, notes Dr. DiDomenico.

**References**


For further reading, see “Preventing Complications Of Plantar Plate Repair” in the August 2017 issue of Podiatry Today, “Understanding The Biomechanics Of Plantar Plate Injuries” in the April 2017 issue or “Expert Insights On Treating Plantar Plate Tears” in the March 2016 issue.

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