Diagnosis and Treatment of Forefoot Disorders. Section 1: Digital Deformities

Clinical Practice Guideline Forefoot Disorders Panel: James L. Thomas, DPM,[1] Edwin L. Blitch, IV, DPM,[2] D. Martin Chaney, DPM,[3] Kris A. Dinucci, DPM,[4] Kimberly Eickmeier, DPM,[5] Laurence G. Rubin, DPM,[6] Mickey D. Stapp, DPM,[7] and John V. Vanore, DPM[8]

This clinical practice guideline (CPG) is based upon consensus of current clinical practice and review of the clinical literature. The guideline was developed by the Clinical Practice Guideline Forefoot Disorders Panel of the American College of Foot and Ankle Surgeons. The guideline and references annotate each node of the corresponding pathways.

Introduction to Forefoot Disorders (Pathway 1)

Forefoot pain is a common presenting complaint seen by foot and ankle surgeons. Patients often describe their pain in a vague and encompassing manner. The purpose of this clinical practice guideline is to review the varied pathologies that comprise the differential diagnosis of forefoot pain, with the exclusion of disorders of the first ray. The pathologies in the differential diagnosis range from acquired orthopedic deformities (eg, hammertoes, digital deformities) to overuse problems and traumatic injuries. These clinical problems, encountered daily by the foot and ankle surgeon, typically involve the lesser toes and metatarsals and their respective joints. Presented in this document are current practice guidelines for the diagnosis and treatment of hammertoe (digital deformities) (Pathway 2); central metatarsalgia (Pathway 3); Morton's neuroma (Pathway 4); tailor's bunion (Pathway 5); and trauma (Pathway 6).

Address correspondence to: James L. Thomas, DPM, University of Florida, Department of Orthopaedics and Rehabilitation, 655 West 8th St, Jacksonville, FL 32209. E-mail: jlthomas@hsc.wvu.edu.

[1]Chair, Jacksonville, FL; [2]Charleston, SC; [3]San Antonio, TX; [4]Scottsdale, AZ; [5]Champaign, IL; [6]Mechanicsville, VA; [7]Augusta, GA; [8]Gadsden, AL.

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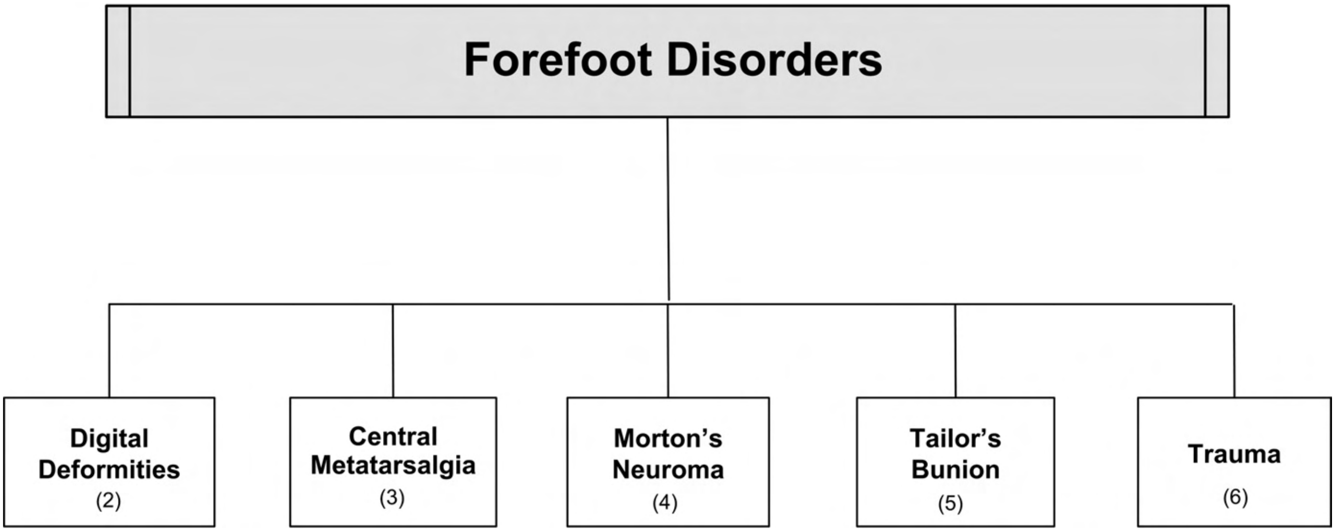
Digital Deformities (Pathway 2)

Digital deformities are among the most common forefoot pathologies encountered by foot and ankle surgeons. These deformities may be either congenital or acquired, with the incidence of digital deformities greater among females than males in almost all age groups (1). Whereas biomechanical dysfunction is usually discussed as the primary cause of digital deformities, these pathologies also may be caused by a variety of other conditions including neuromuscular and arthritic disorders (2-4). The proper identification of the deforming forces and resultant tendon and capsuloligamentous imbalance is critical in determining the treatment plan. Digital deformities may occur as an isolated entity or as a component of other foot and ankle conditions (1, 5).

Significant History (Pathway 2, Node 1)

Patients presenting with digital deformities may either report varying degrees of pain or be asymptomatic. If pain is present, it may occur dorsally, medially, laterally, at the distal end of the toe, or plantar to the respective metatarsal head. Dorsal pain may be secondary to pressure from footwear, whereas pain at the distal end of the toe may be secondary to contracture and the resultant shift of pressure away from the more plantar padded area of the toe.

Patients may report a history of deformity since birth or early childhood. More commonly, patients will have first noticed positional changes of the toe during either early adulthood or in later years. Patients may state either that the extent of deformity of the toe seems to have reached an endpoint, or that they are still noticing a



PATHWAY 1

progressive increase in the deformity. They may complain of difficulty fitting into shoes secondary to the extent of the deformity of the toe. Usually the pain is exacerbated by pressure from footwear, although pain also may be experienced when not wearing shores. Trauma (eg, a malunited phalangeal fracture) may be an etiology of digital deformity, but this is much less common than congenital deformity or deformities acquired over the years.

Significant Findings (Pathway 2, Node 2)

Initial examination of the patient with a digital deformity may or may not reveal pain upon palpation of the toe and metatarsophalangeal joint (MPJ). Erythema and local inflammation over osseous prominences may be present. Hyperkeratotic lesions are commonly found at the proximal interphalangeal joint (PIPJ), distal interphalangeal joint (DIPJ), distal tip of the toe, or plantar to the respective metatarsal head (Fig. 1). Hyperkeratotic lesions also may be found on the medial and/or lateral aspects of the toe or in the webspace, particularly between the fourth and fifth toes. Alternatively, ulceration of the skin may be observed in these areas, sometimes apparent only after debridement of the overlying hyperkeratosis. Plantar pain in the area of the metatarsal head may be found on palpation of this area secondary to increased retrograde pressure from digital contracture or plantar plate rupture.

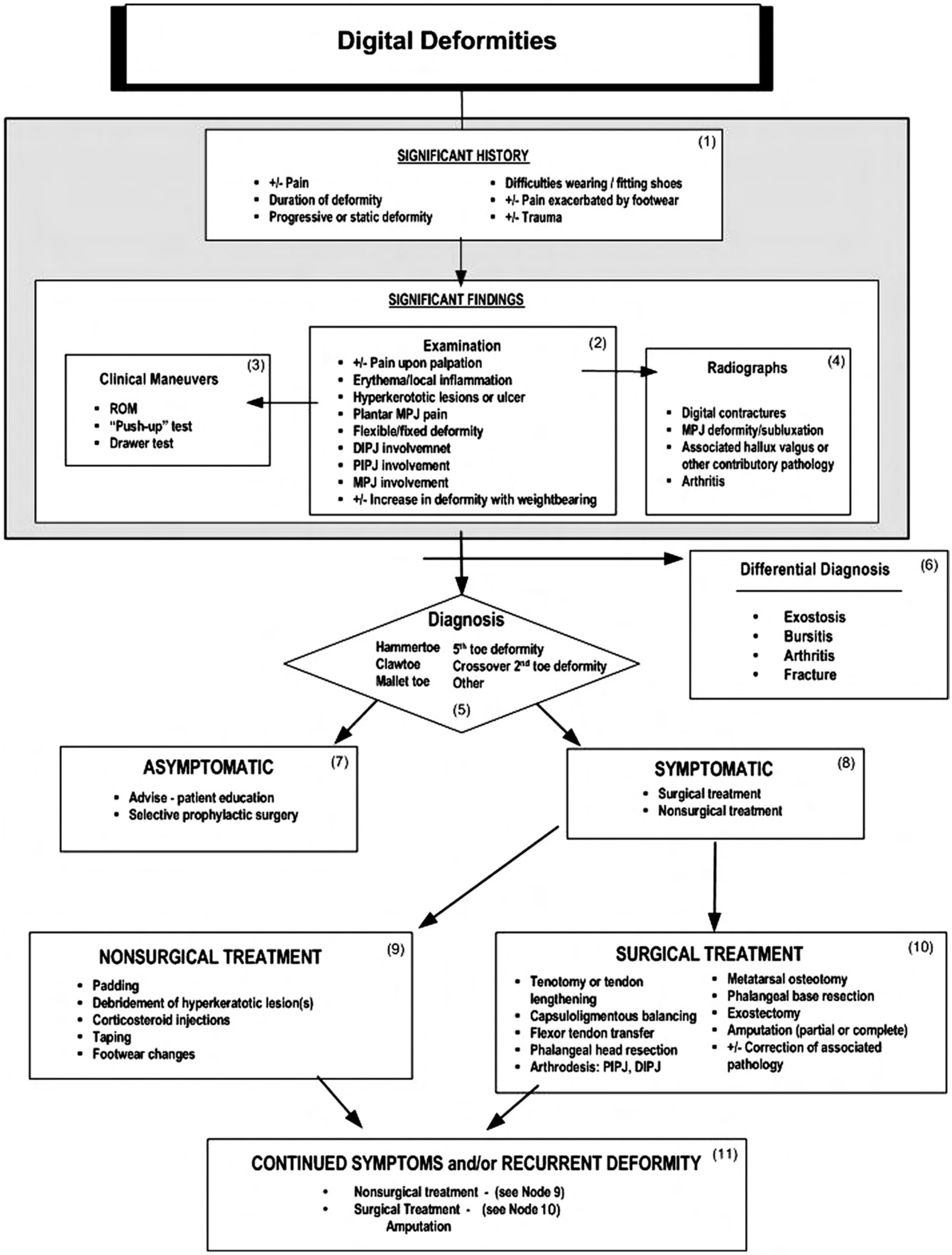
The deformity must be evaluated for flexibility or rigidity, as long-standing deformities generally become less flexible. The degree and character of involvement of the DIPJ, PIPJ, and MPJ must be assessed. Because many digital deformities are increased with weightbearing, the patient is examined both seated and standing. Gait analysis also is beneficial.

Clinical Maneuvers (Pathway 2, Node 3)

Various clinical maneuvers are used to assist in the evaluation of digital deformities. A simple range of motion examination will not only help in determining the flexibility of the deformity but also help in evaluating for arthritic changes. The "push-up" test also is very valuable in determining the reducibility of the deformity (1, 2). In addition, the drawer test of the MPJ will assist in identifying sagittal and transverse instability as well as aid in diagnosing the presence of plantar plate pathology (6, 7).

Radiographic Findings (Pathway 2; Node 4)

During the initial evaluation of the patient, standing radiographs are recommended. The views typically include anterior-posterior, oblique, and lateral; these views aid in determining the extent and location of digital contractures as well as MTP joint deformity and/or subluxation. Associated deformities such as hallux valgus or other contributing pathology (eg, cavus foot, metatarsus adductus) to the digital deformity(ies) also can be evaluated (Fig. 2). In addition, the presence or absence of arthritic changes also may be determined from radiographic evaluation, particularly those changes associated with systemic process such as rheumatoid arthritis and the inflammatory arthritides. Although a bone scan, magnetic resonance imaging (MRI), or computed tomography (CT) scan may be ordered, they are rarely needed in the diagnosis of a lesser digital deformity.


Digital Deformities
SIGNIFICANT HISTORY (1)
+/- Pain
Duration of deformity
Progressive or static deformity
Difficulties wearing / fitting shoes
+/- Pain exacerbated by footwear
+/- Trauma
SIGNIFICANT FINDINGS
Examination (2)
+/- Pain upon palpation
Erythema/local inflammation
Hyperkerototic lesions or ulcer
Plantar MPJ pain
Flexible/fixed deformity
DIPJ involvemnet
PIPJ involvement
MPJ involvement
+/- Increase in deformity with weightbearing
Clinical Maneuvers (3)
ROM
"Push-up" test
Drawer test
Radiographs (4)
Digital contractures
MPJ deformity/subluxation
Associated hallux valgus or other contributory pathology
Arthritis
Differential Diagnosis (6)
Exostosis
Bursitis
Arthritis
Fracture
Diagnosis
Hammertoe
Clawtoe
Mallet toe
5th toe deformity
Crossover 2nd toe deformity
Other
(5)
ASYMPTOMATIC (7)
Advise - patient education
Selective prophylactic surgery
SYMPTOMATIC (8)
Surgical treatment
Nonsurgical treatment
NONSURGICAL TREATMENT (9)
Padding
Debridement of hyperkeratotic lesion(s)
Corticosteroid injections
Taping
Footwear changes
SURGICAL TREATMENT (10)
Tenotomy or tendon lengthening
Capsuloligmentous balancing
Flexor tendon transfer
Phalangeal head resection
Arthrodesis: PIPJ, DIPJ
Metatarsal osteotomy
Phalangeal base resection
Exostectomy
Amputation (partial or complete)
+/- Correction of associated pathology
CONTINUED SYMPTOMS and/or RECURRENT DEFORMITY (11)
Nonsurgical treatment - (see Node 9)
Surgical Treatment - (see Node 10)
Amputation

PATHWAY 2

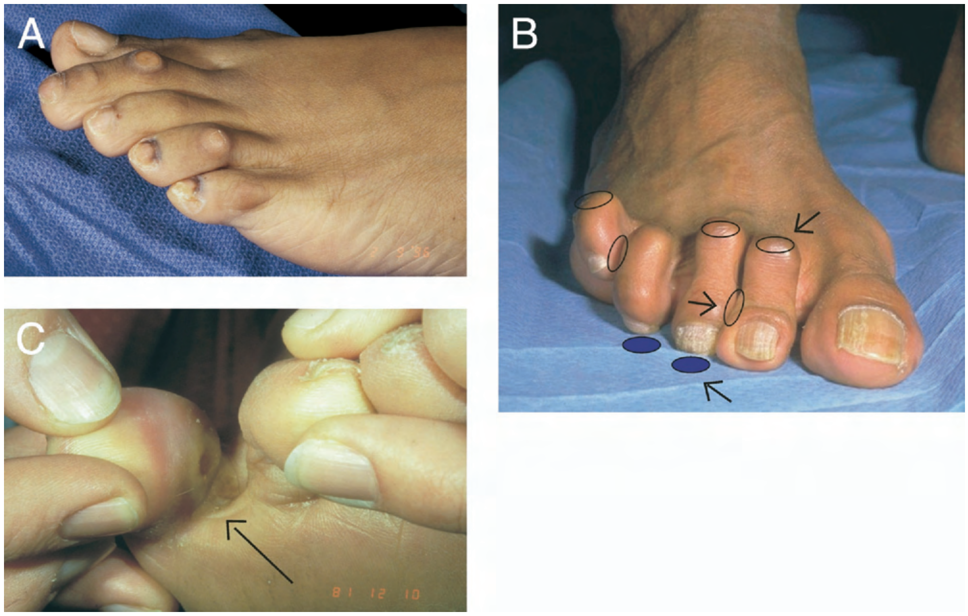


FIGURE 1 Digital deformities are associated with a variety of hyperkeratotic lesions, clavi, or ulcerations including *(A)* dorsally at PIPJ or DIPJ, *(B)* distal tip of toes, or *(C)* medial or lateral condylar surfaces at DIPJs or PIPJs, where adjacent toes rub each other.

FIGURE 2 Digital deformities are generally associated with foot pathologies that result in MTP joint instability and digital contractures. Shown here: *(A)* hallux varus with digital adductus, *(B)* hallux valgus, *(C)* rheumatoid arthritis, and *(D)* pes cavus.

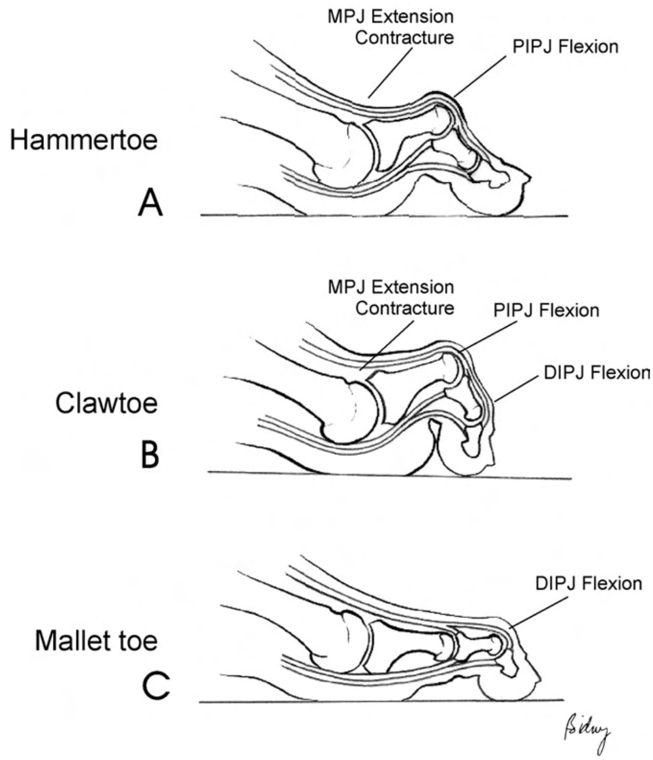


FIGURE 3 Digital deformities may be described by the combination of joint contractures at the digital segments: *(A)* Hammertoe: flexion at the PIPJ with extension at the MPJ with a neutral or hyperextended DIPJ, *(B)* Clawtoe: flexion at both the PIPJ and DIPJ combined with extension at the MPJ, *(C)* Mallet toe: flexion at the DIPJ.

Diagnosis (Pathway 2, Node 5)

After consideration of the history, examination, radiography, and clinical maneuver results, diagnosis of the type and extent of digital deformity can be made. Deformities of the lesser toes are defined classically as hammertoe, clawtoe, and mallet toe (Fig. 3). Although these deformities are all very similar to each other, a few minor differences exist. Hammertoe refers to the deformity that consists of an extension contracture at the MPJ, flexion contracture at the PIPJ, and hyperextension at the DIPJ. Clawtoe deformity exhibits an extension contracture at the MPJ and a flexion contracture at both the PIPJ and DIPJ. A toe whose only deformity consists of a flexion contracture at the DIPJ is termed a mallet toe.

There also are separate and distinct deformities involving the second toe and fifth toe. When an extension contracture is combined with medial deviation (subluxation) at the level of the second MPJ, a "crossover" second toe deformity results (6, 7). This deformity often is combined with a hallux valgus deformity. Pain in and around the second MPJ that occurs before significant subluxation is seen is referred to as "pre-subluxation syndrome." Adduction or abduction digital deformities may involve all lesser MTP joints or, in some cases, divergent digital contractures are seen (Fig. 4). Fifth toe pathology may include deformity in multiple planes (adductovarus deformity), or significant overlap of the fifth toe over the fourth toe may be seen. These toe deformities of the fifth toe may be congenital in nature; other congenital deformities include polydactyly, syndactyly, clinodactyly and macrodactyly (Fig. 5).

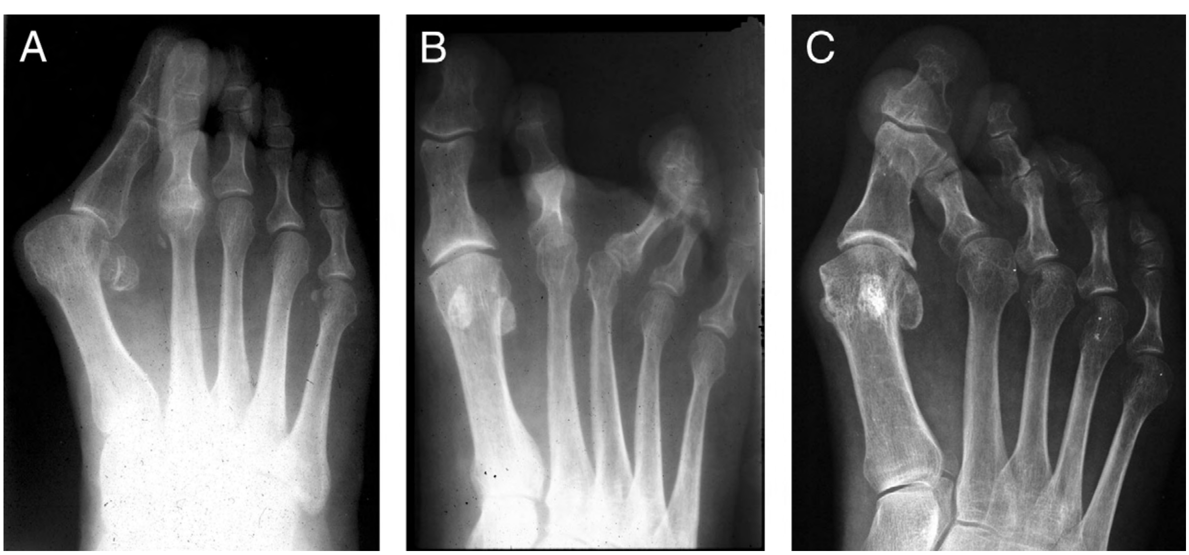


FIGURE 4 Although digital deformities are typically described as sagittal plane deformities, they may take on multiplanar deviation. Radiographs show: *(A)* typical hammertoe with sagittal plane instability, *(B)* divergent toe with abduction of third toe, and *(C)* adduction contracture of the lesser toes.

FIGURE 5 Congenital toe deformities are not uncommon and include *(A)* macrodactyly, *(B)* brachymetatarsia, *(C)* polydactyly, and *(D)* clinodactyly.

Differential Diagnosis (Pathway 2, Node 6)

Other local pathologies besides digital deformity or contracture may give rise to symptoms in a lesser toe. A phalangeal exostosis may be of sufficient size to cause pain from footwear pressure or may result in impingement on an adjacent toe. These may be associated with a hyperkeratotic lesion and may be seen with or without other digital deformity. Bursitis may be present at any area of increased pressure secondary to exostosis or deformity. Many forms of arthritis, particularly rheumatoid arthritis and some of the seronegative arthritides, may manifest themselves in symptoms at the MPJ and PIPJ or DIPJ. A fracture must be ruled out, especially in the setting of acute onset of pain involving injury.

Asymptomatic Digital Deformity (Pathway 2, Node 7)

In the setting of a digital deformity that is asymptomatic, advising the patient on the prevention of future problems (eg, changes in footwear) may be all that is necessary. At times, prophylactic correction of digital deformities in the patient with diabetic peripheral neuropathy may be undertaken to prevent future ulceration.

Symptomatic Digital Deformity (Pathway 2, Node 8)

Symptomatic digital deformities may be treated nonsurgically or surgically, depending on multiple factors. These include degree of deformity, duration and severity of symp-

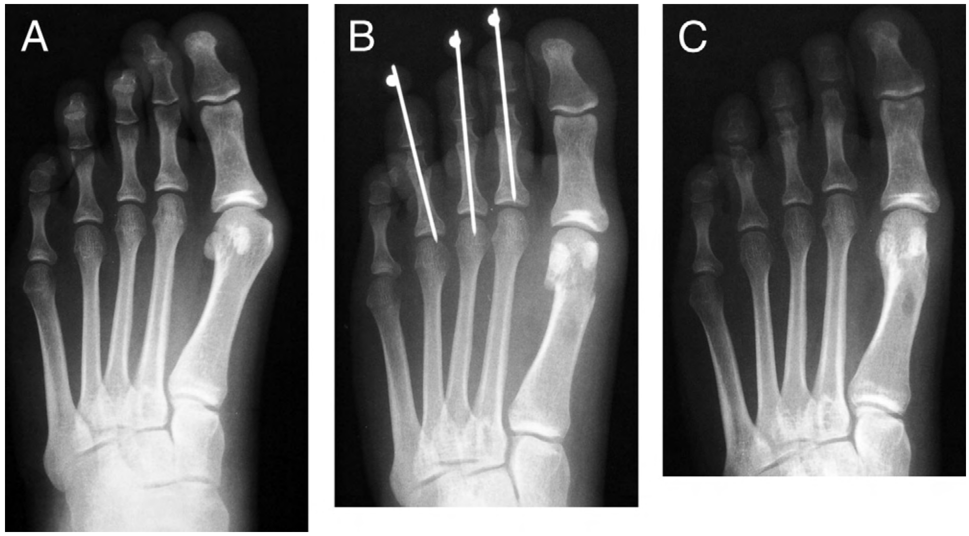


FIGURE 6 *(A)* This patient had digital deformites that included flexion at both the PIPJ and DIPJ. Note the rather long middle phalanges. *(B)* The patient underwent PIPJ fusion of the second, third, and fourth toes combined with arthroplasty of the DIPJ with kirschner wire stabilization as well as hallux valgus correction. (C) This is a radiograph at 1 year postsurgery.

toms, previous treatment, associated medical conditions, and ability to perform work duties comfortably.

Nonsurgical Treatment Options (Pathway 2, Node 9)

Nonsurgical treatment is often the initial treatment choice for the symptomatic digital deformity. Various padding techniques exist, serving to cushion or offload pressure points that may involve both the affected toe(s) as well as its respective metatarsal head plantarly. Orthotic devices or shoe insole modifications using a metatarsal pad may offer relief of excessive metatarsal head pressures. Debridement of associated hyperkeratotic lesions usually is effective in helping to reduce symptoms. If local inflammation or bursitis exists, a corticosteroid injection into the affected area may be beneficial. Taping to reduce and splint flexible deformities may be performed, especially in the setting of an early crossover second toe deformity. Last but not least, footwear changes such as a wider and/or deeper toe box may be used to accommodate the deformity and decrease shoe pressure over osseous prominences.

Surgical Treatment Options (Pathway 2, Node 10)

The surgical treatment of digital deformities includes a spectrum of soft tissue and osseous procedures. The degree and flexibility of the deformity along with any associated pathology determine the surgical procedure(s) to be performed.

When the deformity is manually reducible, tenotomy or tendon lengthening at the level of the MPJ, PIPJ, or DIPJ may be sufficient for deformity correction; however, this may require combining with capsular and/or ligamentous release (or reefing), especially at the level of the MPJ (8-10). In some cases, phalangeal head resection (partial or complete) and/or flexor tendon transfer also may be necessary (11).

When the deformity is only manually semi-reducible or rigid, both osseous and soft tissue procedures often are performed in combination. Osseous procedures of the toe include phalangeal head resection (with or without implant) and arthrodesis of the PIPJ and DIPJ (3, 11-24) (Fig. 6). Sometimes metatarsal osteotomy, partial metatarsal head resection, or phalangeal base resection may be required to achieve complete correction of the digital deformity, especially at the level of the MPJ (1, 2, 25-27) (Fig. 7). Soft tissue procedures are commonly utilized to augment osseous procedures in this patient population; soft tissue procedures include all of the aforementioned procedures for flexible deformities. Exostectomy also may be beneficial, particularly in addressing hyperkeratotic lesions along the medial or lateral aspects of the toe (27, 28). Partial amputation of the toe may be indicated in some cases, especially in conditions involving the fifth toe. In selected cases, complete amputation of a lesser toe may be considered to allow shoe fitting, such as in the coexistence of second toe deformity and hallux valgus deformity in an elderly patient (29).

Correction of associated conditions may be indicated in the surgical care of some digital deformities. This is especially true in crossover second toe deformity, where hallux valgus deformity often is seen concurrently and may influence attempts at correction of the second toe deformity (30).

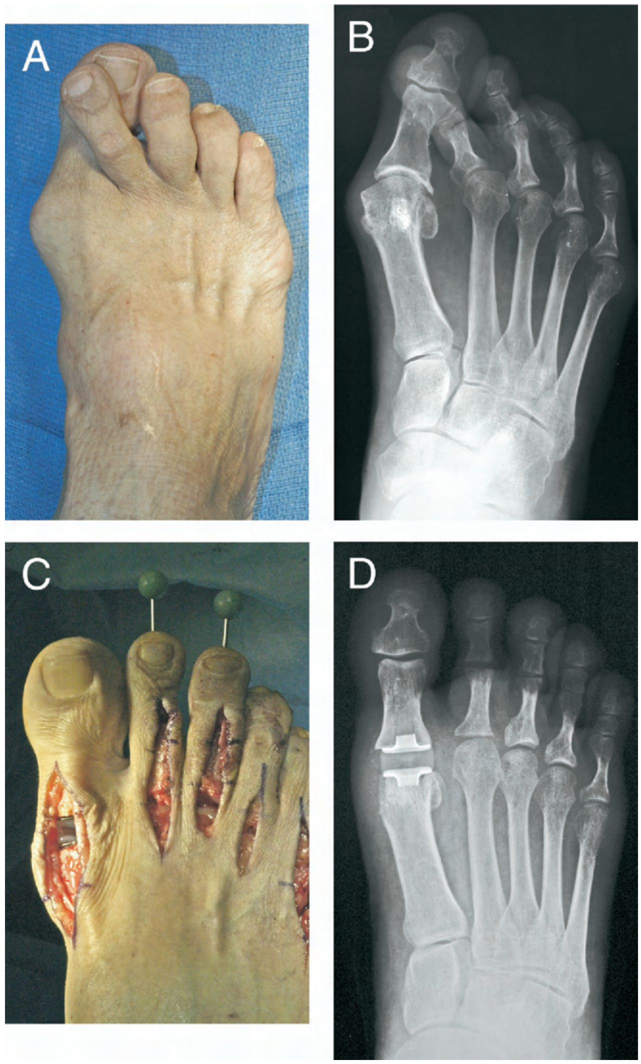


FIGURE 7 *(A)* Digital deformities may be very complex, as seen in this 65-year-old female and *(B)* presurgical radiograph with a cross-over second toe but degree of adduction contracture of all the lesser toes combined with a hallux valgus deformity. *(C)* Surgical management included bunionectomy with implant arthroplasty and PIPJ fusion of the second, third, and fourth toes with MPJ releases including a proximal phalangeal base resection of the second toe. *(D)* Shown here is a postsurgical radiograph.

Surgical repair of associated tears of the plantar plate also has been advocated (6) (see Section 2. Central Metatarsalgia, Fig. 8). In addition, correction of other forefoot, midfoot, or hindfoot conditions contributing to the formation of digital deformity may be indicated.

Continued Symptoms (Pathway 5, Node 11)

Treatment of the patient who continues to experience symptoms after surgical care of a digital deformity may require a variety of revisional surgical techniques and/or nonsurgical measures. In some cases, recurrence of the original deformity or migration of phalangeal segments occur as a complication of the original repair. Revisional surgery alternatives are similar to the above for original procedural selection.

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Diagnosis and Treatment of Forefoot Disorders. Section 2. Central Metatarsalgia

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Central Metatarsalgia (Pathway 3)

Central metatarsalgia involves pathology of the second, third, and fourth metatarsals and their respective metatarsophalangeal joints (MPJs). Metatarsal pathology may be secondary to a variety of problems including trauma, length abnormalities, structural deformity, and others. Pathology of the central MPJs is also secondary to numerous different etiologies and encompasses both osseous and soft tissue conditions. Osseous changes may be secondary to arthritis, whereas soft tissue conditions can be complex, often leading to instability of the MPJ and resultant multiplanar deformities. Systemic inflammatory conditions may produce both osseous and soft tissue abnormalities in the areas of the central MPJs.

Significant History (Pathway 3, Node 1)

Patients presenting with complaints related to the second, third, and fourth metatarsals and their respective MPJs typically relate a history of pain in the area of the ball of the foot, with or without swelling and/or discoloration. They may report a history of partial or complete stiffness of the affected joint(s). Symptoms are usually of gradual onset, tend to be progressive in nature, and may have been aggravated by a recent change in activity or footwear. Frequently there is no history of trauma (1, 2). Related complaints may include the development of plantar calluses in the area of where symptoms occur as well as a gradual change in appearance or position of one or more toes (3).

Significant Findings (Pathway 3, Node 2)

Examination of the patient with central metatarsalgia symptoms may reveal edema and or inflammation in the area of the involved metatarsal(s) or MPJs. Pain on palpation of the affected metatarsal or joint is typically present (4). Pain involving the MPJ usually is exacerbated upon reaching end range of motion with manual testing. Decreased range of motion or crepitus may indicate arthrosis or other osseous changes at the MPJ. Alternatively chronic hyperextension of the MPJ may predispose the plantar plate and collateral ligaments to attenuate and rupture (5). In these joints, manual stress testing of the lesser MPJ may demonstrate instability as evidenced by dorsal translocation of the digit at the metatarsal head (6). Typically patients with plantar plate rupture have pain with palpation plantarly at the metatarsal head or flexor crease of the affected MPJ (7).

Change in position or alignment of the toe may or may not be seen in central metatarsalgia, as patients may present with complaints of pain at the MPJ prior to the development of associated digital deformities. If digital deformities are present, they may be multiplanar, flexible, or nonflexible. A hyperkeratotic lesion plantar to the affected metatarsal or MPJ may be present and may contribute to the patient's symptomatology (Fig. 1). Diagnostic blocks often are of great help in localizing the area of the patient's symptoms and establishing an accurate diagnosis.

Diagnostic Testing: Radiographic Evaluation (Pathway 3, Node 3)

Radiographic evaluation of the patient with central metatarsalgia symptoms should include weightbearing anterior-posterior (AP), lateral, and oblique views. A plantar axial

Address correspondence to: James L. Thomas, DPM, University of Florida, Department of Orthopaedics and Rehabilitation, 655 West 8th St, Jacksonville, FL 32209. E-mail: jlthomas@hsc.wvu.edu.
[1]Chair, Jacksonville, FL; [2]Charleston, SC; [3]San Antonio, TX; [4]Scottsdale, AZ; [5]Champaign, IL; [6]Mechanicsville, VA; [7]Augusta, GA; [8]Gadsden, AL.

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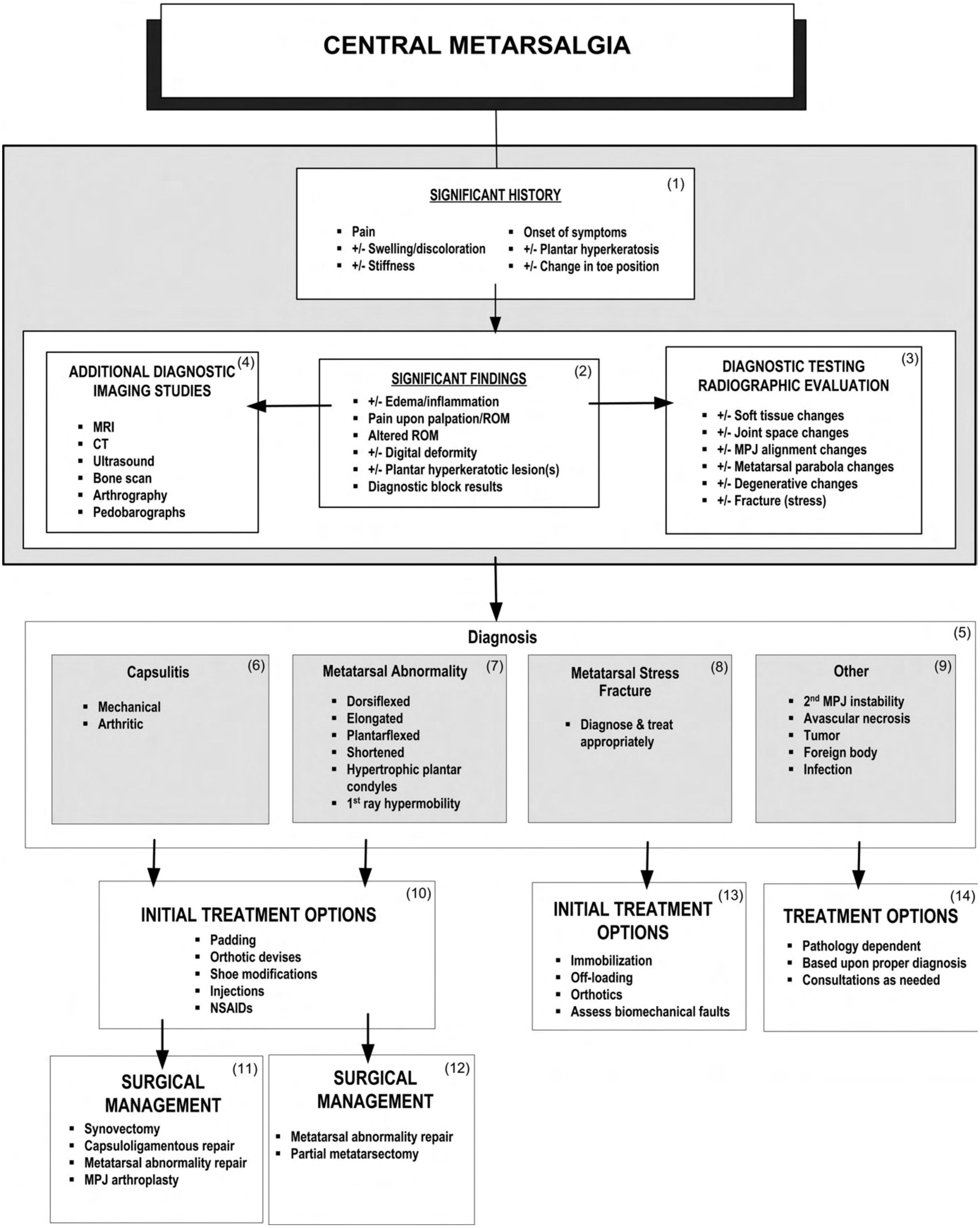

CENTRAL METARSALGIA
SIGNIFICANT HISTORY (1)
Pain
+/- Swelling/discoloration
+/- Stiffness
Onset of symptoms
+/- Plantar hyperkeratosis
+/- Change in toe position
ADDITIONAL DIAGNOSTIC IMAGING STUDIES (4)
MRI
CT
Ultrasound
Bone scan
Arthrography
Pedobarographs
SIGNIFICANT FINDINGS (2)
+/- Edema/inflammation
Pain upon palpation/ROM
Altered ROM
+/- Digital deformity
+/- Plantar hyperkeratotic lesion(s)
Diagnostic block results
DIAGNOSTIC TESTING RADIOGRAPHIC EVALUATION (3)
+/- Soft tissue changes
+/- Joint space changes
+/- MPJ alignment changes
+/- Metatarsal parabola changes
+/- Degenerative changes
+/- Fracture (stress)
Diagnosis (5)
Capsulitis (6)
Mechanical
Arthritic
Metatarsal Abnormality (7)
Dorsiflexed
Elongated
Plantarflexed
Shortened
Hypertrophic plantar condyles
1st ray hypermobility
Metatarsal Stress Fracture (8)
Diagnose & treat appropriately
Other (9)
2nd MPJ instability
Avascular necrosis
Tumor
Foreign body
Infection
INITIAL TREATMENT OPTIONS (10)
Padding
Orthotic devises
Shoe modifications
Injections
NSAIDs
INITIAL TREATMENT OPTIONS (13)
Immobilization
Off-loading
Orthotics
Assess biomechanical faults
TREATMENT OPTIONS (14)
Pathology dependent
Based upon proper diagnosis
Consultations as needed
SURGICAL MANAGEMENT (11)
Synovectomy
Capsuloligamentous repair
Metatarsal abnormality repair
MPJ arthroplasty
SURGICAL MANAGEMENT (12)
Metatarsal abnormality repair
Partial metatarsectomy

PATHWAY 3

FIGURE 1 Forefoot submetatarsal hyperkeratotic lesions vary considerably from *(A)* a localized discrete one to *(B)* a diffuse lesion under an isolated metatarsal or *(C)* under multiple metatarsals. *(D)* Biomechanical evaluation with Harris mat or computer force plate analysis may provide useful clinical information regarding pressure distribution or loading points. Soft tissue pathology such as ganglia, *(E)* bursa, and *(F)* skin pathology such as verruca and porokeratoses must be considered.

view may also be beneficial in evaluating the structure and position of the central metatarsal heads.

Radiographs are evaluated for both soft tissue and osseous changes. Soft tissue is investigated for edema, foreign bodies, and other abnormalities. Joint dislocation, subluxation, or irregularities of the metatarsal head or phalangeal base may be seen. Alignment of the second, third, and fourth MPJs as well as any abnormalities of the metatarsal parabola are assessed on the AP radiograph (Fig. 2). The presence of degenerative and/or avascular changes may be indicated by erosions, joint space narrowing, subchondral cysts, osteophyte formation, sclerosis, and alteration in the normal contour of the metatarsal head. A metatarsal stress fracture may or may not be radiographically apparent. Indeed, the first radiographic evidence of a stress fracture may be reflected by healing bone callus several weeks after the fracture had occurred (Fig. 3).

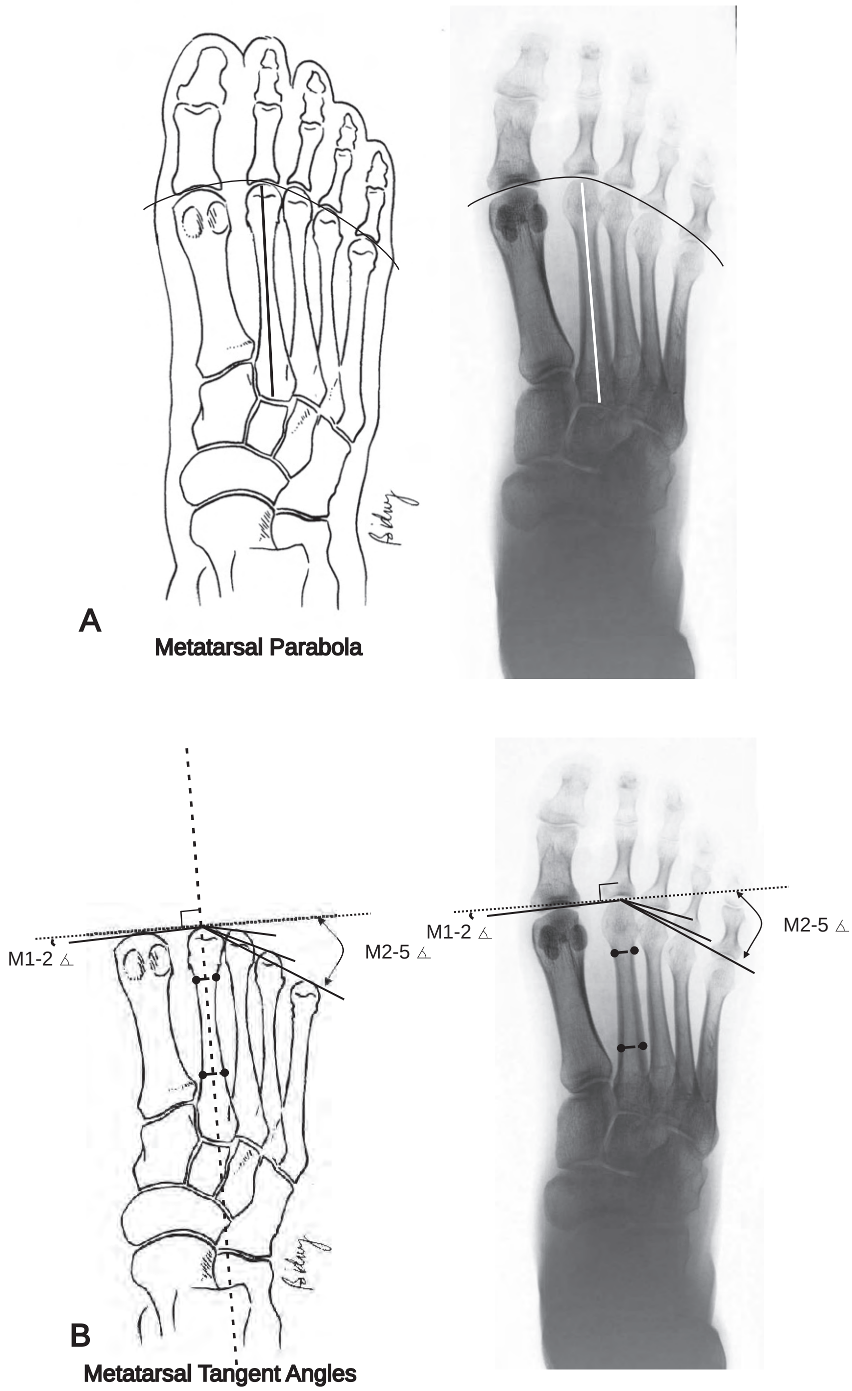

FIGURE 2 Metatarsal deformities are often correlated with length relationships to each other on standard weightbearing radiographs. *(A)* Parabola have been described as well as *(B)* metatarsal tangents. Certainly, osseous relationships vary from patient to patient, but weightbearing radiographs have been used as an objective parameter to explain the forefoot pathologies discussed in this document. *(Metatarsal tangents from ACFAS Scoring Scale, 2006.)*

Additional Diagnostic Imaging Studies (Pathway 3, Node 4)

Evidence of pathology at the MPJ joint or metatarsal may be further substantiated with the use of magnetic resonance imaging (MRI), computed tomography (CT), diagnostic ultrasound, radionucleotide scanning, and arthrography. These more advanced imaging techniques may assist in determining the presence and extent of both soft tissue and osseous damage in this area of the foot.

MRI, CT, and radionucleotide scanning are helpful in determining the presence of metatarsal stress fracture or articular pathology such as an arthritide, Freiberg's infraction, or plantar plate rupture not appreciated radiographically (7). Ultrasound may support clinical evidence of soft tissue trauma/edema and may offer an alternative diagnostic aid for suspected plantar

FIGURE 3 Metatarsal stress fractures are common. This patient had *(A)* radiographs taken 2 weeks prior in the emergency room that were negative and now show complete fracture with displacement of the second metatarsal. *(B)* A follow-up radiograph 3 weeks later shows exuberant bone callus indicative of the unstable nature of the fracture.

plate ruptures (8). The use of intra-articular radio-opaque dye is beneficial in documenting a plantar plate rupture if extravasation of the dye is found to be present (9). Plantar pressure studies may be helpful in identifying weightbearing anomalies of the forefoot.

Diagnosis (#3; Node 5)

Establishment of the correct diagnosis may be very challenging as quite a variety of pathologies may be etiologic of pain in this anatomic location. These include:

— Capsulitis (mechanical, arthritic, or secondary to second MPJ instability)
— Metatarsal abnormalities (dorsiflexed, elongated, plantarflexed, shortened, hypertrophic plantar condyles and first ray hypermobility)
— Metatarsal stress fracture
— Second MPJ Instability
— Other (avascular necrosis, tumor, foreign body, infection)

Capsulitis (Pathway 3, Node 6)

Capsulitis of the central MPJs may be secondary to mechanical or arthritic etiologies (Fig 4). Mechanical causes include any condition that results in increased forces through the joint itself as well as overload to the plantar metatarsal head. This may be associated with tears of the plantar plate or ligament disruption. Arthritic conditions include any of the inflammatory arthritidies such as rheumatoid arthritis and many of the seronegative arthritidies. Laboratory testing often is indicated in the establishment of an arthritic process. In the case of a mechanical etiology of capsulitis, treatment includes offloading and management of any contributing biomechanical abnormality with padding and/or orthotic therapy. Oral anti-inflammatory medication as well as local injection of a corticosteroid also may be beneficial. If the patient fails to respond appropriately to these measures, surgical treatment may be necessary. This would include synovectomy along with correction of any contributing pathology (eg, metatarsal abnormality) and repair of any capsuloligamentous tears if present (see Node 9).

When arthritis of the MPJ is the cause of capsulitis, attempts should be made to establish an accurate diagnosis of the arthritic process involved. These attempts include the previously-mentioned laboratory testing, as well as joint aspiration and rheumatologic consultation/referral if indicated. Treatment for an inflammatory arthritic condition of the central MPJs includes all of the nonsurgical and surgical alternatives previously listed for mechanically-induced capsulitis. In addition, arthroplasty-type procedures may be necessary to remove painful ostephytes, remove loose bodies, perform other procedures such as chondroplasty or joint implantation. In some cases, metatarsal head resection may at times also be considered, but this usually is done only in the presence of significant deformity, such as in the performance of pan metatarsal head resection in the setting of rheumatoid arthritis (Fig 5).

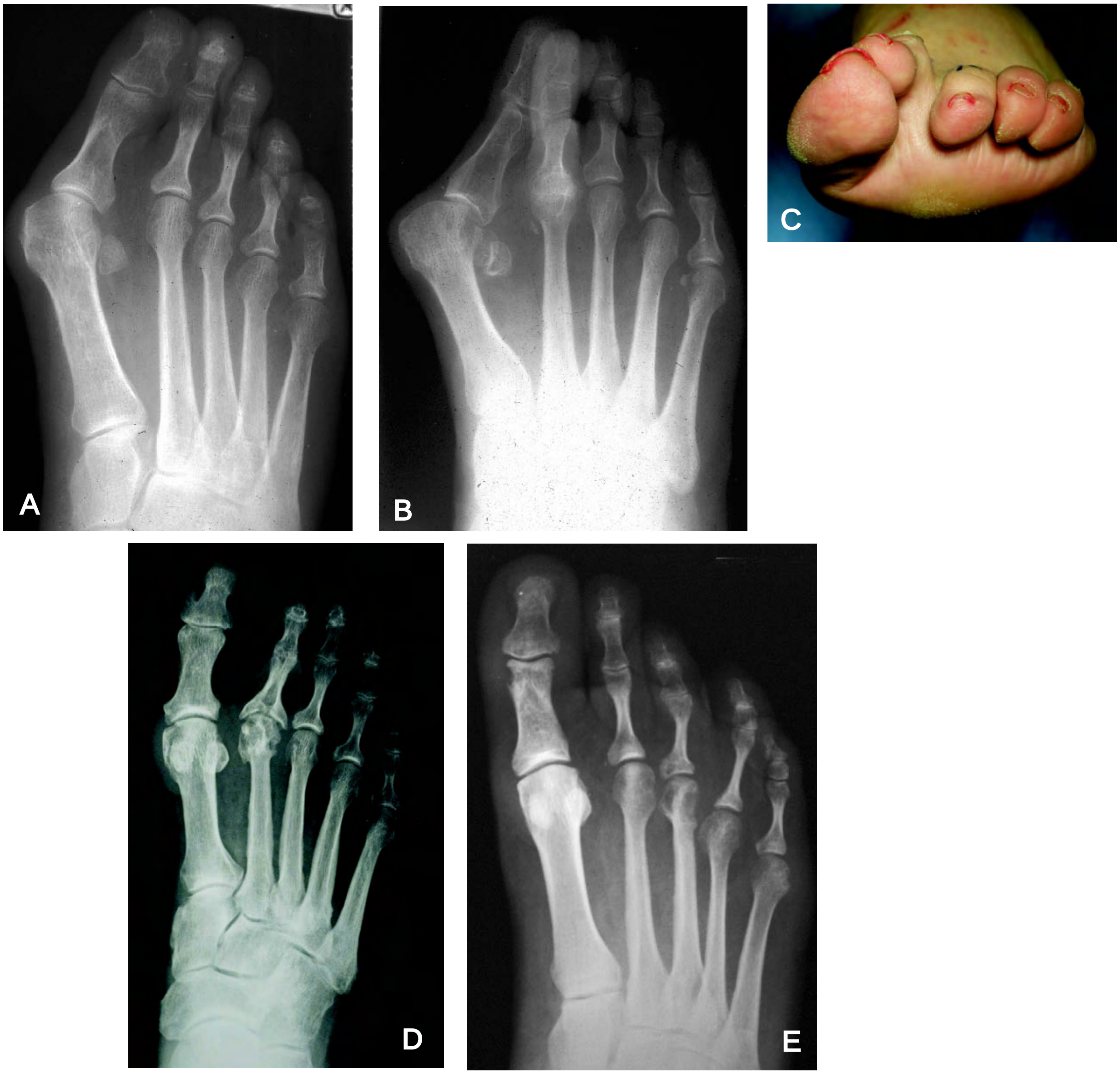

FIGURE 4 *(A)* Lesser metatarsalgia or localized inflammation of a lesser MPJ is a symptom that is commonly associated with hallux valgus deformities with involvement of the second MPJ. *(B)* Forefoot derangements frequently include hammertoe deformities with progressive contracture of lesser MTP joints that may lead to complete joint subluxation in the sagittal plane or *(C)* with a multiplanar deformity with "cross-over" toe. Inflamed or stiff MTP joints may represent *(D)* a feature of diabetic Charcot foot or *(E)* an inflammatory arthritis with involvement of the third MPJ with significant metatarsal head erosions.

Metatarsal Abnormality (Pathway 3, Node 7)

Sagittal plane abnormalities of the central metatarsals may be the result of anatomical variations that are congenital, developmental, or acquired (perhaps from trauma or prior surgery). These abnormalities can manifest themselves as dorsiflexed (elevated), elongated, plantarflexed, and shortened metatarsals, or as hypertrophic plantar condyles. Hypermobility of the first ray may result in a lateral transfer of stress away from the first metatarsal, with resultant symptoms. Any of these conditions, either alone or in combination, can cause increased load or pressure around one or more of the central metatarsals, producing pain, bursal formation, and/or a hyperkeratotic lesion.

Although an elevated (dorsiflexed) metatarsal may be congenital, more frequently it is a result of trauma or a surgical procedure. Consequently, the adjacent metatarsal heads bear more weight, which may result in pain or plantar hyperkeratotic lesions.

An elongated central metatarsal extends beyond the "normal" metatarsal parabola. The developmental form may be a result of delayed closure of the growth center for that

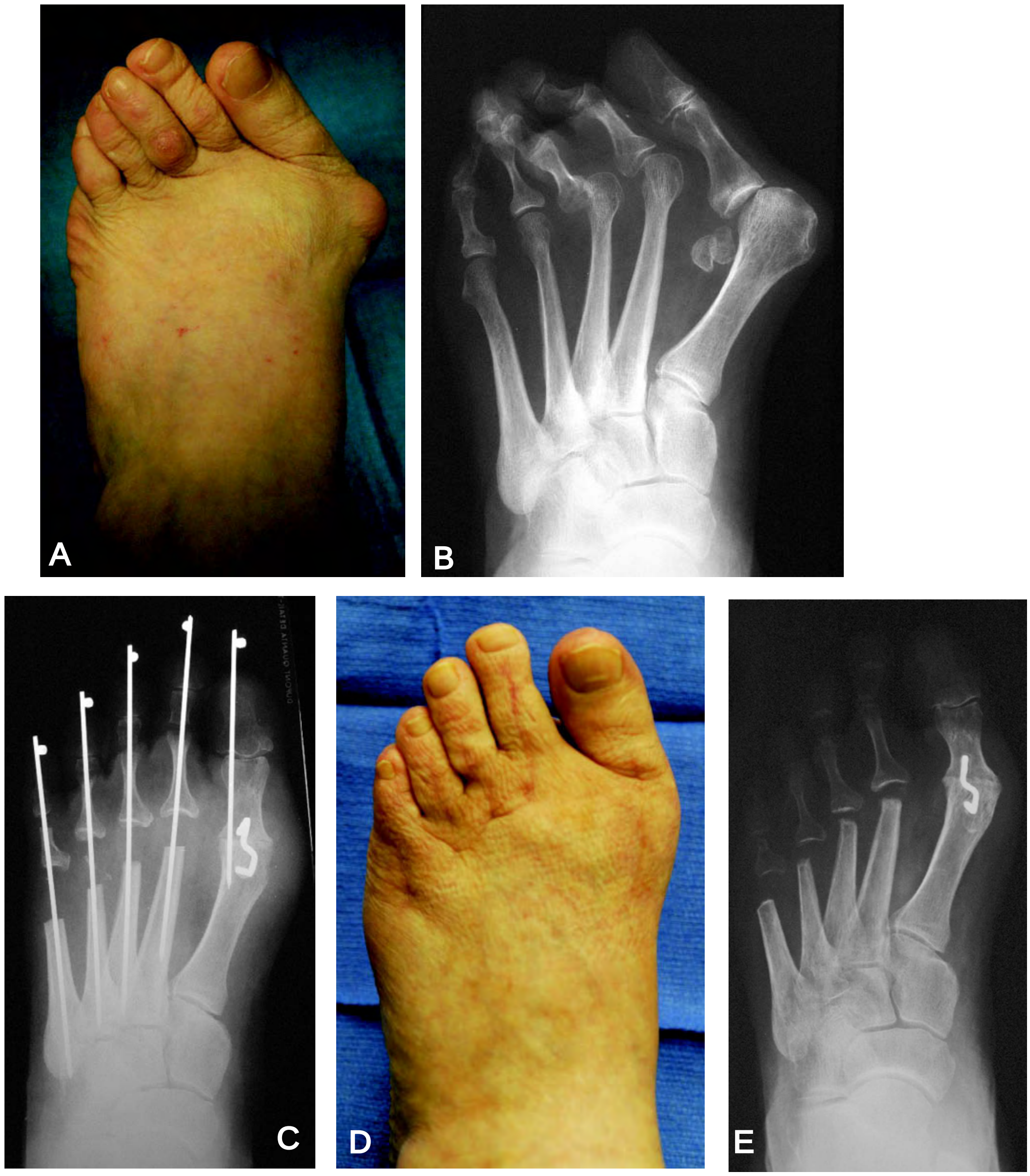

FIGURE 5 *(A)* The MPJs are a target area for rheumatoid arthritis and this patient exhibits severe deformity *(B)* with dislocation of the first, second, and third MPJs. *(C)* This patient underwent forefoot arthroplasty with first MPJ fusion and panmetatarsal head resections. *(D and E)* Shown are the foot and a radiograph at 1 year postsurgery.

particular metatarsal. However, the elongation may be only relative if adjacent metatarsals have been shortened from either trauma or surgery. During the gait cycle, particularly at the push-off phase, the elongated metatarsal tends to bear more weight for a longer period of time, resulting in symptoms of increased stress under the involved metatarsal head.

A structurally plantarflexed metatarsal results in a more plantar location of its respective metatarsal head in comparison to the adjacent metatarsals. Congenital plantarflexed metatarsal is rare, but if present it is commonly associated with an anterior cavus foot deformity. The condition of an isolated plantarflexed metatarsal most often exists as a result of trauma or prior surgery. A clinical plantar prominence of the metatarsal head may also be the result of increased retrograde force from an associated digital deformity with dorsal contraction of the MPJ. This results in increased weightbearing stress, which may result in pain or a hyperkeratotic lesion beneath the metatarsal.

A shortened metatarsal may be associated with a congenital or acquired syndromic condition (10) or iatrogenically induced secondary to a surgical procedure. In addition to the decreased length of the metatarsal, relative elevation to the adjacent metatarsals results due to the inherent declination of the metatarsals. This shortening may increase the load or

FIGURE 6 *(A)* Management of metatarsalgia associated with an elongated third metatarsal and a discrete keratotic lesion. *(B).* This patient underwent a shortening third metatarsal osteotomy to reduce localized pressures and a discrete sub-third metatarsal head lesion.

pressure to the adjacent metatarsal heads as they bear more weight, at times producing pain and/or hyperkeratotic lesions. Congenital shortening of a metatarsal (brachymetatarsia) usually becomes clinically evident between the ages of 4 and 15 years. Brachymetatarsia is relatively rare, with a reported incidence of 0.022% or 1 in 4586, and affects females more commonly than males in an approximate 25:1 ratio (11, 12). Several retrospective studies report the fourth ray being the most commonly affected (10). A congenitally short metatarsal may also result in metatarsalgia secondary to increased weightbearing forces around the adjacent metatarsal(s). An elevated toe can cause footwear difficulties and painful hyperkeratotic lesions. Physeal abnormalities and other changes may indicate associated syndromic conditions. Complaints from patients seeking treatment for a congenitally short fourth metatarsal may be only for cosmetic concerns.

Congenital hypertrophy of the plantar condyles of the metatarsal heads is rare. The condition is most commonly the result of exostosis formation secondary to an arthritic condition or a degenerative process. Inflammatory joint disease with or without bursitis may also be a significant contributing factor. Patients with atrophy or anterior displacement of the plantar fat pad will appear to have this condition and may increase weightbearing stress under the involved metatarsal head(s). The lateral plantar condyle is most commonly involved.

Hypermobility of the first ray has been reported to result in overload of the second metatarsal head with resultant pathology in this area. Treatment of associated first ray hypermobility may be necessary in the treatment of central metatarsalgia.

Each of these conditions creates similar symptomatology in the area of the metatarsal with the deformity or in the area of adjacent metatarsals. Elongated or plantarflexed metatarsals as well as metatarsals adjacent to an elevated metatarsal sustain increased weightbearing forces. In addition, metatarsals with hypertrophy of the plantar condyles show a similar pattern of increased forces and possible focal keratoses at the level of the condyles.

Nonsurgical treatment involves medications, offloading the painful joint or metatarsal head, and treating any associated biomechanical pathology. Treatment includes padding, orthoses, and rocker-bottom shoe modifications. Nonsteroidal anti-inflammatory drugs and corticosteroid injections may also be used (13).

Surgical treatment is indicated for those patients who fail to respond to nonsurgical care or for patients in whom nonsurgical care would not be considered beneficial.

Dorsiflexed (elevated) metatarsals are surgically treated by an osteotomy at either the proximal or distal aspect of the metatarsal to plantarflex the metatarsal with the goal of reestablishing the normal weight bearing pattern of the forefoot. Care must be taken to avoid over- or under-correction of the deformity.

Structurally plantarflexed metatarsals are surgically treated by an elevating osteotomy at either the proximal or the distal aspect of the metatarsal to re-establish the sagittal plane alignment of the bone and a normal metatarsal parabola (14) (Fig 6). Care must be taken to prevent common complications of excessive elevation or shortening resulting in transfer lesions or metatarsalgia. Painful dorsal exostosis or prominence secondary to excessive elevation and floating toe/lack of toe purchase may also occur (15).

Surgical procedures for a shortened metatarsal include acute or gradual lengthening of the metatarsal, soft tissue release, correction of associated digital deformity, and in some cases syndactyly. Specific techniques used for meta-

FIGURE 7 *(A)* Brachymetatarsia most often involves the fourth metatarsal. This patient was surgically treated with distraction osteogenesis. *(B)* Fixator is in place. *(C)* Radiography at 1-year postsurgery shows very nice reconstitution of metatarsal length and morphology. *(Courtesy Alan Banks, DPM, Atlanta, GA)*

tarsal lengthening include metatarsal osteotomy, bone grafting, and distraction osteogenesis, (Fig. 7). Potential complications include under- or over-correction, decreased joint motion, delayed union, nonunion, malunion, or graft failure. Amputation at the MTP joint should be avoided because of the risk of subsequent adjacent toe deformity (16).

Surgical treatment of enlarged plantar condyles is performed when the symptoms of metatarsalgia are due to the prominence and resultant increased pressure or load caused by this abnormality. Surgical treatment of enlarged plantar condyles involves remodeling or resection (condylectomy) of the involved metatarsal condyles. If other etiologic factors such as those described previously are determined to exist, consideration should be given to other procedures to treat the coexisting deformity.

Operative treatment of first ray hypermobility may be necessary in some instances. This is usually done via medial column arthrodesis.

Metatarsal Stress Fracture (Pathway 3, Node 8)

Stress fractures of the central metatarsals develop when the bone is subjected repetitively to sub-failure loads (17-19). Stress fractures make up as much as 20% of all sports-related injuries (20). A greater incidence of these injuries among females has been reported (21). Patients with chronic inflammatory arthropathies, severe osteoporosis, marked joint deformity, or receive chronic corticosteroid therapy are at high risk of developing stress fractures (22). Stress fractures of the second metatarsal base are most commonly seen in dancers (23-26). Although the length of the first metatarsal has been implicated as a risk factor for weight transference, equivalent rates of fracture in short, average, and long first metatarsal conditions have been reported (27). Numerous studies have shown that abnormal mechanics of the first ray may transfer weight to the adjacent metatarsals and lead to stress transference and fracture of the adjacent metatarsal (28-30).

The majority of metatarsal stress fractures occur in the second and third metatarsals. Radiographic examination may be normal for several weeks after the onset of symptoms. In cases of uncertain diagnosis or in cases where more aggressive treatment might be indicated (ie, high performance athletes), a technetium bone scan, MRI, or CT scan may assist in the early detection of a stress fracture (31).

The primary treatment of a central metatarsal stress fracture is immobilization and offloading with the use of a walking boot or surgical shoe along with activity modification (32, 33). Proper shoes and orthoses are used to control abnormal biomechanical influences and may relieve symptoms. Failure to address pre-existing biomechanical abnormalities that result in metatarsal stress fractures can lead to complete fracture or possible recurrence (34, 35). Return to regular activity or sport is allowed once adequate fracture healing has been accomplished. In the event of malunion, the metatarsal may become elevated, plantar-flexed, and/or shortened and this may increase the load to adjacent metatarsals. Surgical treatment of a metatarsal stress fracture is rarely necessary. However, surgery may be required in cases of complete fracture, failure to heal with usual nonsurgical measures, or in cases of malunion (24).

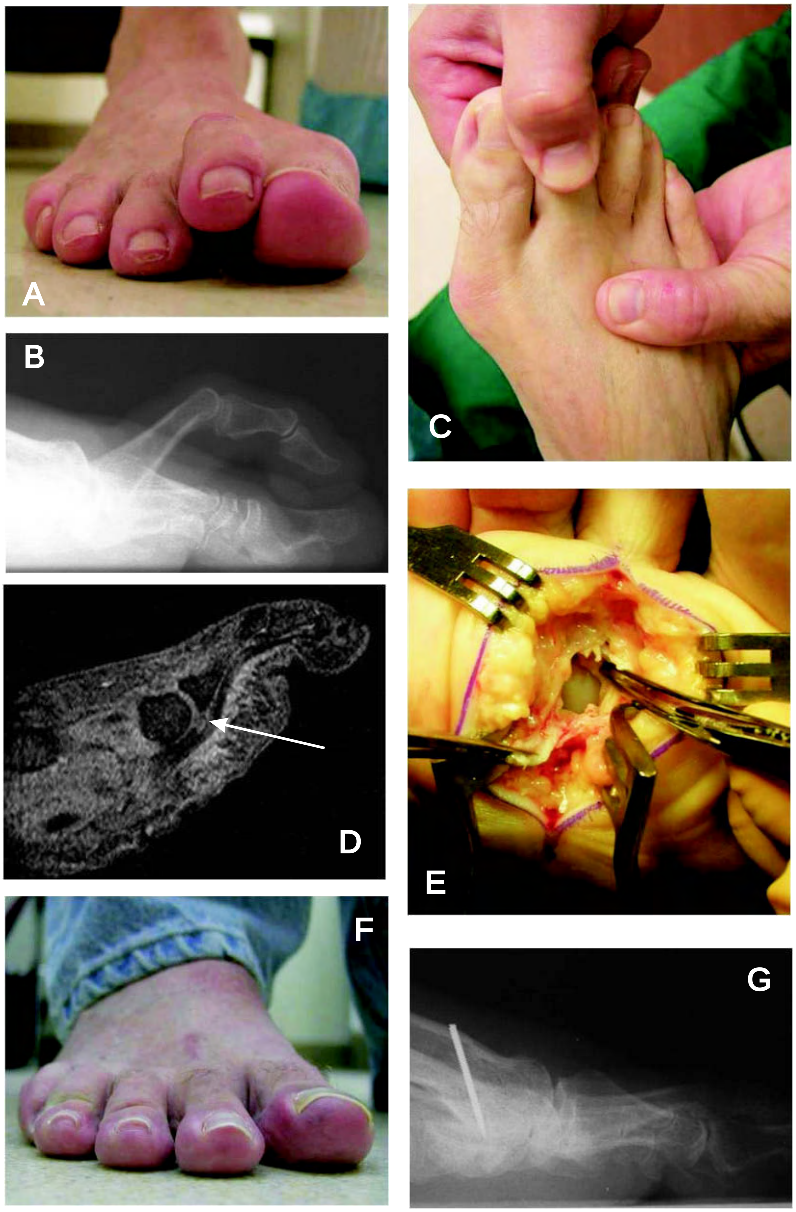

FIGURE 8 *(A)* Plantar plate rupture leading to digital instability and chronic localized pain is the presenting symptom in this patient. *(B)* Lateral radiograph shows loss of toe purchase with a *(C)* positive MPJ stress test. *(D)* The MRI image shows discontinuity of the plantar plate and its phalangeal base insertion is confirmed by *(E)* an intraoperative photo illustrating rupture. *(F and G)* Postsurgically, this patient shows restoration of toe purchase, both clinically and radiographically. *(Courtesy Craig Camasta, DPM, Douglasville, GA)*

Other (Pathway 3, Node 9)

Other causes of central metatarsalgia-related symptoms also exist. These include second MTP joint instability, avascular necrosis, tumor, foreign body, and infection.

Second MPJ Instability The second MPJ is most frequently implicated in MPJ instability. Second MPJ instability with or without inflammation of the articular and periarticular structures can lead to multiplanar malalignment. Second MPJ instability has been described as predislocation syndrome (36), plantar plate dysfunction (37), mono-articular non-traumatic synovitis, MPJ capsulitis and synovitis, metatarsalgia, and crossover second toe deformity. Many factors that include both mechanical and inflammatory conditions have been described to contribute to this condition. Possible mechanical causes include trauma to the plantar plate and supporting ligaments and joint capsule; an elongated second metatarsal; Freiberg's infraction; prior surgical intervention; congenital deformities; and the forces produced on the second MTP joint by an adjacent hallux valgus deformity. Inflammatory conditions such as isolated synovitis or systemic inflammatory arthropathies may be causative factors as well.

The confirmation of an unstable joint is determined by clinical and radiographic evaluations (Fig 8). This condition is characterized by pain and inflammation of the second MPJ and varying degrees of digital deviation in the transverse and sagittal plane. As the condition progresses a positive dorsal stress test on the digit at the MPJ (drawer test) reveals subluxation and, sometimes in later stages, dorsal dislocation (36). Transverse plane deviation of the digit may be better appreciated on weightbearing examination and is commonly present with sagittal plane instability. It should be noted that clinical instability at the MPJ is not necessarily pathognomonic for a plantar plate rupture; rather it may be identified in patients with ligamentous laxity and chronic plantar plate attenuation (37).

Weightbearing radiographic evaluation reveals the joint alignment changes. MRI and arthrography may be beneficial in further delineating the competency of the plantar plate.

Nonsurgical treatment may involve offloading of the second MPJ, splinting or taping of the second toe, orthoses, rocker-bottom shoe modifications and metatarsal padding. Nonsteroidal anti-inflammatory drugs and corticosteroid injections also may be used (13).

Surgical treatment is indicated for those patients who have failed nonsurgical care or for patients who are not candidates for nonsurgical treatment. Surgical correction is aimed at restoring the alignment and function of the second MPJ and any associated digital deformity. Surgical options include interphalangeal joint arthrodesis, flexor tendon transfer (38), reefing of the plantar-lateral capsule, collateral ligament repair, plantar plate repair (37), MPJ arthroplasty, and various metatarsal osteotomies (13).

Avascular Necrosis of the Metatarsal Head A unique finding of the lesser MTP joint (typically the second) is osteochondrosis. Commonly referred to as Freiberg's infraction, these cartilage and osseous changes represent an avascular necrosis of the metatarsal head (39-41). Surgical management of this condition may include: distal metatarsal osteotomy (42-46), implant arthroplasty (47-50), resection arthroplasty (51) and interpositional grafting (52, 53), and interpositional soft tissue grafts (54, 55).

Tumor Pain and/or swelling in the forefoot may be secondary to tumors of soft tissue or bone. Timely diagnosis and any indicated consultation and /or referral are important. Treatment is specific to the type of tumor present.

Foreign Body Symptoms secondary to a foreign body in the forefoot are not uncommon. A symptomatic retained foreign body may be old or new and may be associated with a significant wound (laceration, gunshot or puncture wound) or show no discernable portal of entry. Excision of the offending foreign body is the treatment of choice. In the acute setting confirmation of tetanus prophylaxis is indicated.

Infection Infection of the central metatarsal area may be secondary to a variety of etiologies including puncture wound, foreign bodies, diabetic ulceration (see *Diabetic Foot Disorders: A Clinical Practice Guideline,* 2006, supplement to *Journal of the Foot and Ankle Surgeons*), laceration, fungal infections etc. It may involve joint, soft tissue, bone or occur in combination. Identification of the anatomic structure(s) involved and the causative organism(s) will direct treatment.

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Diagnosis and Treatment of Forefoot Disorders. Section 3. Morton's Intermetatarsal Neuroma

Clinical Practice Guideline Forefoot Disorders Panel: James L. Thomas, DPM,[1] Edwin L. Blitch, IV, DPM,[2] D. Martin Chaney, DPM,[3] Kris A. Dinucci, DPM,[4] Kimberly Eickmeier, DPM,[5] Laurence G. Rubin, DPM,[6] Mickey D. Stapp, DPM,[7] and John V. Vanore, DPM[8]

This clinical practice guideline (CPG) is based upon consensus of current clinical practice and review of the clinical literature. The guideline was developed by the Clinical Practice Guideline Forefoot Disorders Panel of the American College of Foot and Ankle Surgeons. The guideline and references annotate each node of the corresponding pathways.

Morton's Intermetatarsal Neuroma (Pathway 4)

Nerve pathologies are a common cause of forefoot pain and include diverse conditions with similar symptoms. The symptoms are characteristic of sensory nerve disorders and differ from other musculoskeletal conditions.

Morton's intermetatarsal neuroma is a compression neuropathy of the common digital nerve (Fig. 1). It is most commonly seen in the third intermetatarsal space, but it also can be seen in other intermetatarsal spaces (Fig. 2). A neuroma may occur in more than one intermetatarsal space and may be bilateral. Neuromas are more prevalent in adults beginning in the third decade of life, and are more common in females than males (1-7).

Significant History (Pathway 4, Node 1)

The subjective history reported by the patient is usually characteristic for this entity. The patient may complain of numbness and tingling, and/or radiating, burning pain. The pain often is localized at the plantar aspect of the respective intermetatarsal space, but it can radiate into the adjacent toes. Patients frequently describe a "lump" on the bottom of their foot or a feeling of walking on a rolled-up or wrinkled sock. The symptoms may increase with weightbearing and activity. Closed-toed shoes and especially tight-fitting footwear can increase the symptoms. Patients report relief of symptoms upon removing or changing their shoes. They also may get relief from massaging the foot and moving the toes.

Significant Findings (Pathway 4, Node 2)

Objective findings are unique to Morton's neuroma and can provide further insight to aid the clinician in the diagnostic process. Although patients frequently describe numbness, a sensory deficit may or may not be present on examination. The clinical presentation may demonstrate a splaying or divergence of the digits (8). Usually little to no edema or inflammation is seen clinically. Reproduction of the pain with palpation to the intermetatarsal space is typical. Care must be taken to press in the intermetatarsal space and avoid the metatarsal heads.

Clinical Maneuvers (Pathway 4, Node 3)

Various clinical maneuvers have been described to assist the clinician in the diagnosis of Morton's neuroma. The patient may demonstrate a Mulder's sign (9, 10), elicited by squeezing the forefoot and applying plantar and dorsal pressure. A positive test result consists of a click or pop that can be felt or heard; this can be painful to the patient. Symptoms of Morton's neuroma may be replicated through the Gauthier' test, in which the forefoot is squeezed and medial to lateral pressure is applied (5). Bratkowski described a test that involves hyperextending the toes and rolling the thumb of the examiner in the area of symptoms. This maneuver may reveal a tender, thickened, longitudinal mass (11). Patients with Morton's neuroma also may demonstrate Tinel's sign and Valleix phenomenon.

Address correspondence to: James L. Thomas, DPM, University of Florida, Department of Orthopaedics and Rehabilitation, 655 West 8th St, Jacksonville, FL 32209. E-mail: jlthomas@hsc.wvu.edu

[1]Chair, Jacksonville, FL; [2]Charleston, SC; [3]San Antonio, TX; [4]Scottsdale, AZ; [5]Champaign, IL; [6]Mechanicsville, VA; [7]Augusta, GA; [8]Gadsden, AL.

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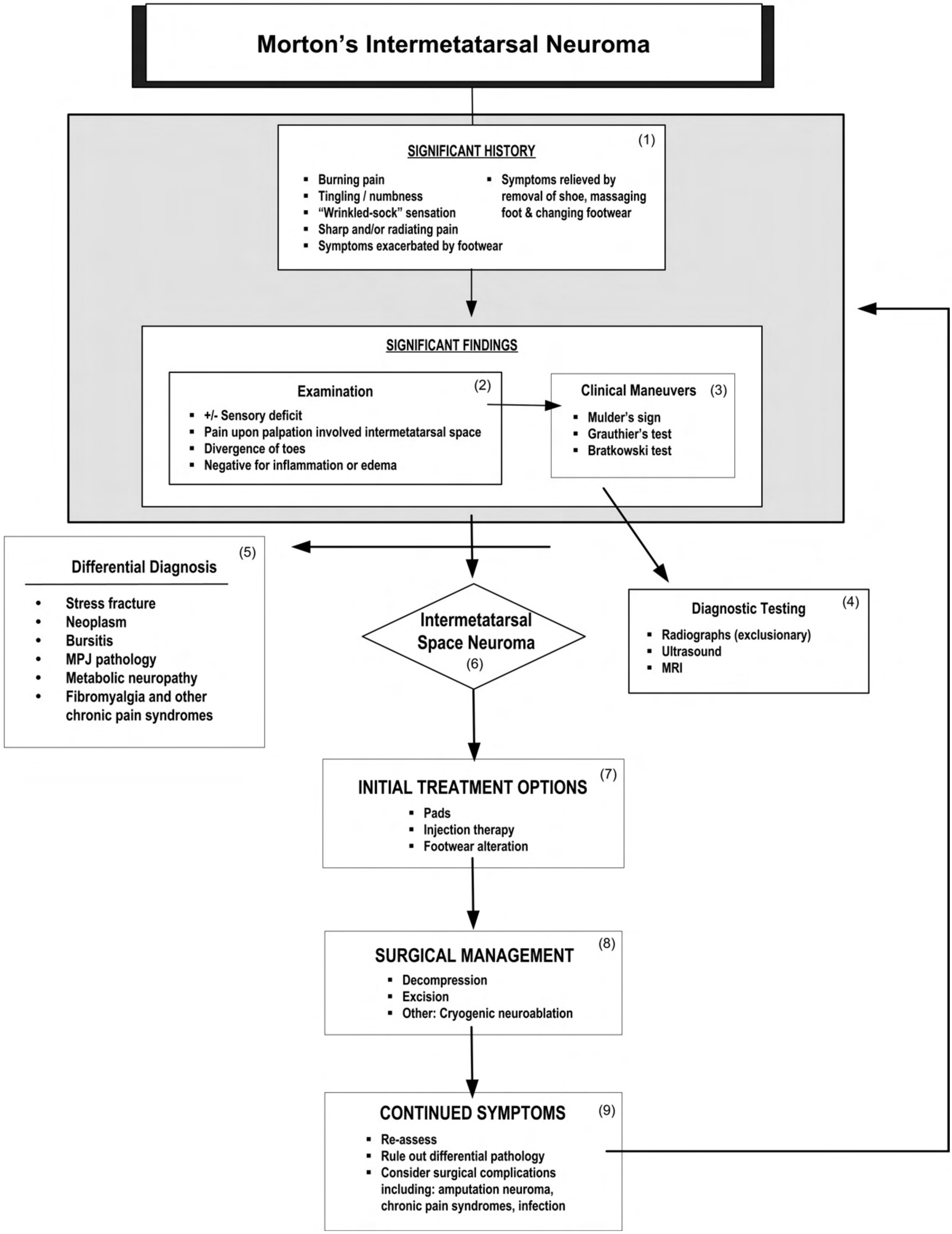
Morton's Intermetatarsal Neuroma
SIGNIFICANT HISTORY (1)
Burning pain
Tingling / numbness
"Wrinkled-sock" sensation
Sharp and/or radiating pain
Symptoms exacerbated by footwear
Symptoms relieved by removal of shoe, massaging foot & changing footwear
SIGNIFICANT FINDINGS
Examination (2)
+/- Sensory deficit
Pain upon palpation involved intermetatarsal space
Divergence of toes
Negative for inflammation or edema
Clinical Maneuvers (3)
Mulder's sign
Grauthier's test
Bratkowski test
Differential Diagnosis (5)
Stress fracture
Neoplasm
Bursitis
MPJ pathology
Metabolic neuropathy
Fibromyalgia and other chronic pain syndromes
Intermetatarsal Space Neuroma (6)
Diagnostic Testing (4)
Radiographs (exclusionary)
Ultrasound
MRI
INITIAL TREATMENT OPTIONS (7)
Pads
Injection therapy
Footwear alteration
SURGICAL MANAGEMENT (8)
Decompression
Excision
Other: Cryogenic neuroablation
CONTINUED SYMPTOMS (9)
Re-assess
Rule out differential pathology
Consider surgical complications including: amputation neuroma, chronic pain syndromes, infection

PATHWAY 4

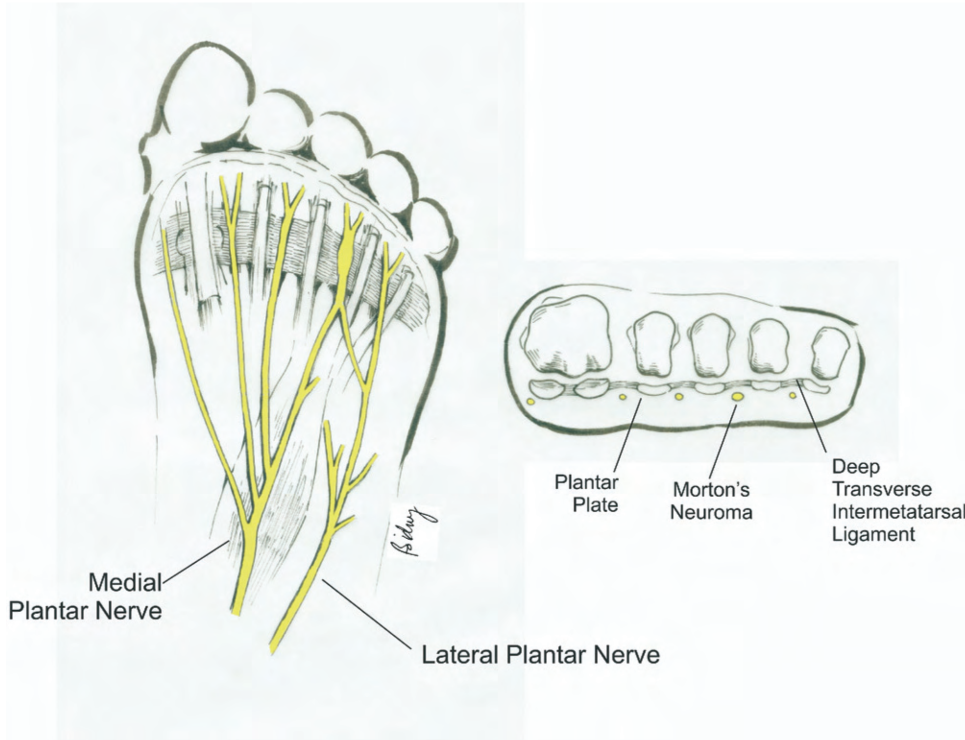

FIGURE 1 This illustrates the anatomy of the plantar nerves and the relationship of Morton's neuroma to the deep transverse intermetatarsal ligament.

Diagnostic Testing (Pathway 4, Node 4)

Diagnostic testing for a Morton's neuroma may include plain radiography, ultrasound, and magnetic resonance imaging (MRI) (12).

Radiographs should be routinely ordered to rule out musculoskeletal pathology. Neuromas will not be visible on radiographs. Although increased proximity of the adjacent metatarsal heads has been thought to result in more pressure on the intermetatarsal nerve, Grace and colleagues found no statistically significant relationship between radiographic findings and the clinical presence of neuromas (13).

Ultrasound also has been recommended for diagnostic evaluation of the interspaces (14). A neuroma will appear as an ovoid mass with hypoechoic signal (15, 16). This mass will be parallel to the long axis of the metatarsals and is best observed on the coronal view (17-19). MRI can be a useful diagnostic tool, but it should be reserved for atypical presentations or to rule out multiple neuromas. The neuroma is best identified on T1 weighted

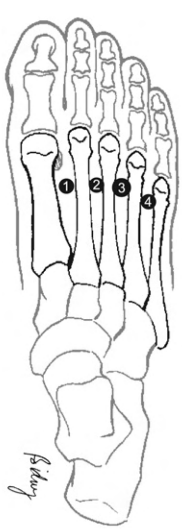

Figure 2 Intermetarsal Neuroma Frequency of Interspace Involvement

Author	Number of Patients	❶	❷	❸	❹
Bartolomei & Wertheimer (1983)	233	1%	29%	64%	6%
Addante et al (1986)	100	2.5%	18%	66%	4%
Bennett et al (1995)	100	-	32%	68%	-
Friscia et al (1992)	222	-	-	91%	-

FIGURE 2 The reported frequency of intermetatarsal space neuromas has varied among investigators, although the third intermetatarsal space predominates in all series.

images. It will be revealed as a well-demarcated mass with low signal intensity (20).

Differential Diagnosis (Pathway 4, Node 5)

The diagnosis of Morton's neuroma requires a careful clinical history correlated with the condition's unique set of characteristics found on examination. Care must be taken to rule out other possible etiologies of symptoms in this area of the forefoot (19, 21, 22). The differential diagnosis of Morton's neuroma includes:

- Stress fracture (23)
- Neoplasm (eg, rheumatoid nodule) (24-27)
- Bursitis (23, 25, 28)
- MPJ pathology (27-29)
- Metabolic neuropathy
- Fibromyalgia and other chronic pain syndromes

Diagnosis (Pathway 4, Node 6)

The diagnosis of Morton's neuroma is primarily a clinical diagnosis that is reached after examination and diagnostic testing have ruled out other possible etiologies of symptoms.

Initial Treatment Options (Pathway 4, Node 7)

Nonsurgical care of Morton's neuroma is centered on alleviating pressure and irritation of the nerve. Initially, patients should wear shoes that have a wide toe box to allow the metatarsals to spread out. High-heel shoes should be avoided.

Metatarsal pads also can be beneficial. These pads, placed proximal to the metatarsal heads, help alleviate pressure on the nerve and assist in spreading out the metatarsals.

Injection therapy includes a variety of alternative approaches to nonsurgical treatment. A local anesthetic block can be used to provide some diagnostic information, but it has not been shown to be therapeutic (30). Corticosteroid injection is cited as having an 11% to 47% success rate, with multiple injections obtaining better results (31-34, 35). Care should be taken to avoid overusing corticosteroid injections; the literature contains reports of atrophy of the plantar fat pad secondary to cortisone injections, as well as joint subluxation (36). Dilute alcohol injections (3-7 injections of 4% alcohol administered at 5-10 day intervals) has been associated with an 89% success rate, with 82% of patients achieving complete relief of symptoms (37). Several other investigators have verified the efficacy of sclerosing injections as a nonsurgical treatment alternative (38, 39 40). Another injection modality involves injecting the nerve with vitamin B12 (cyanocobalamin); this has been discussed in the literature, but the effects observed may have been due to the preserving agent, benzyl alcohol (41). Phenol also has been reported as a safe and effective injection modality (42).

Surgical Treatment Options (Pathway 4, Node 8)

Excision of the affected portion of the nerve is perhaps the most common approach to neuroma surgery (1, 7, 19, 43). Excision requires identifying the common digital portion of the nerve and following the structure to the proper digital branches. Care must be taken to avoid other structures in the area. Various surgical approaches have been used, the most common of which is a dorsal incision over the involved intermetatarsal space (44, 45) (Fig. 3). Plantar incisional approaches are most often used in revisionary procedures, although they also have been described as an initial surgical approach (19, 22, 46, 47). Excision may also be elected when prior decompression surgery has failed to resolve symptoms (48).

Decompression of the intermetatarsal nerve through the use of endoscopic and minimally invasive techniques has been reported in recent years (49-51). Open decompression of the nerve by releasing the deep transverse intermetatarsal ligament and performing an external neurolysis has been described (52). In addition, transposition with nerve release has been shown to be useful (53, 54).

Cryogenic neuroablation is a minimally invasive procedure that applies a temperature of -50°C to -70°C to the nerve. This results in Wallerian degeneration of the axons and myelin, while leaving the epineurium and perineurium intact. Preserving these structures helps prevent stump neuromas during nerve regeneration; this is the greatest advantage of cryogenic ablation. There are limitations of this procedure. The results are not permanent, and it is not as effective on larger neuromas or in the presence of thick fibrosis. Several investigators have advocated this technique (55, 56).

Continued Symptoms (Pathway 4, Node 9)

All treatments may have complications, with either ineffective relief of symptoms or worsening of the condition. Careful reassessment in failed surgical management may reveal tarsal tunnel or other proximal nerve pathology. Complications of surgical procedures include infection, hematoma, stump neuroma formation, and chronic pain syndromes. Surgical failures may require more aggressive surgical intervention including plantar approach and implantation of the proximal portion of nerve into muscle (57, 58).

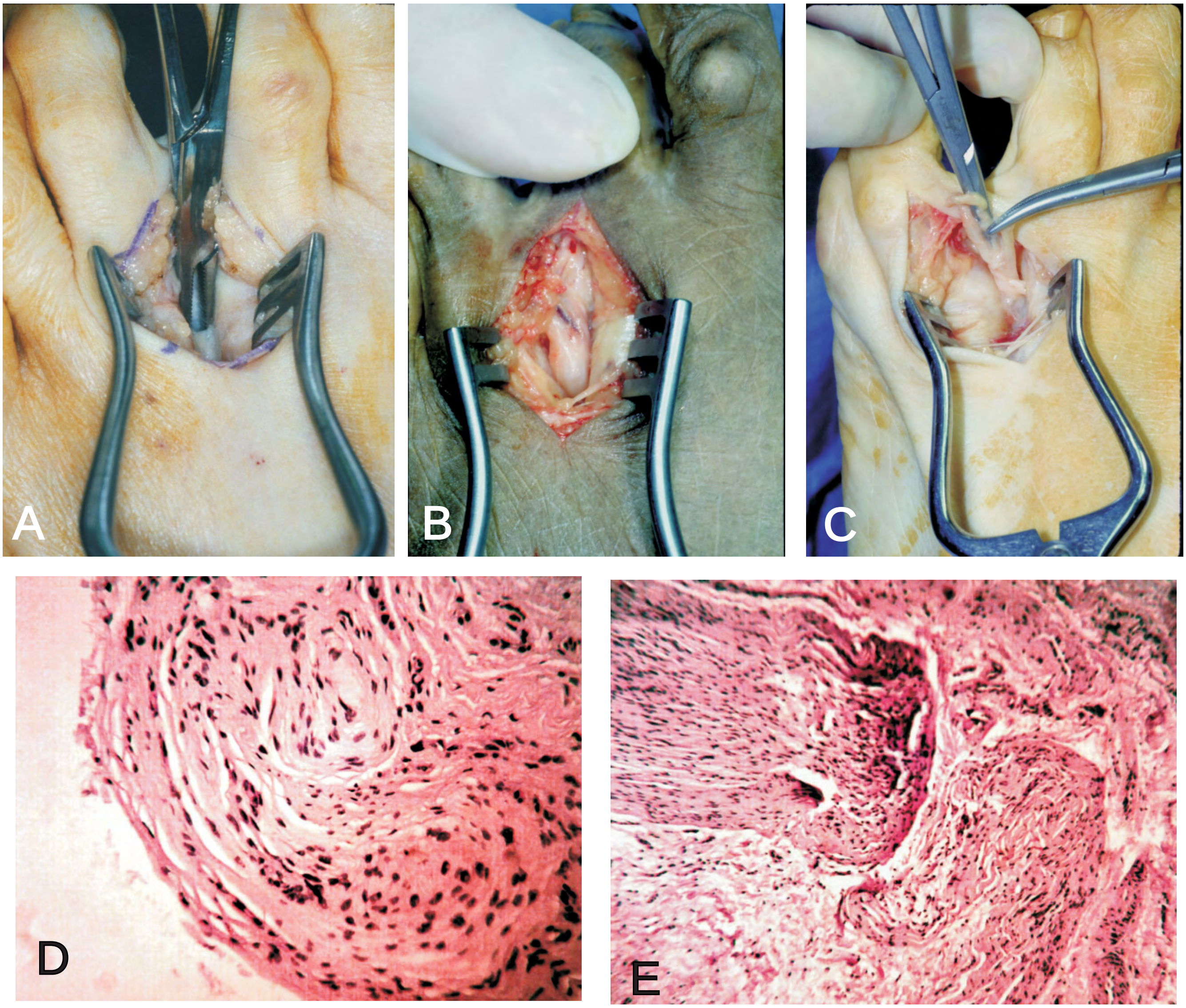

FIGURE 3 The intermetatarsal neuroma lies *(A)* below the deep transverse intermetatarsal ligament, which is implicated in its symptomatology. Surgical dissection generally begins dorsally and involves severing the deep transverse intermetatarsal ligament to visualize the neuroma. *(B)* Dissection distal isolating the proper digital branches is performed followed by *(C)* proximal isolation of the common digital branches prior to its excision. Histologic examination reveals the nature of this nerve lesion as a traumatic neuroma with distorted or angulated nerve segments and disarray of neural elements *(D)* 400x and *(E)* 250x. *(Pathology images courtesy of Max Sanders, MD, Gadsden AL).*

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Diagnosis and Treatment of Forefoot Disorders. Section 4. Tailor's Bunion

Clinical Practice Guideline Forefoot Disorders Panel: James L. Thomas, DPM,[1] Edwin L. Blitch, IV, DPM,[2] D. Martin Chaney, DPM,[3] Kris A. Dinucci, DPM,[4] Kimberly Eickmeier, DPM,[5] Laurence G. Rubin, DPM,[6] Mickey D. Stapp, DPM,[7] and John V. Vanore, DPM[8]

This clinical practice guideline (CPG) is based upon consensus of current clinical practice and review of the clinical literature. The guideline was developed by the Clinical Practice Guideline Forefoot Disorders Panel of the American College of Foot and Ankle Surgeons. The guideline and references annotate each node of the corresponding pathways.

Tailor's Bunion (Pathway 5)

Tailor's bunion (also called bunionette) involves deformity of the fifth metatarsophalangeal joint (MPJ), much like a bunion that occurs medially. Although tailor's bunion typically involves deformity with lateral prominence of the fifth metatarsal head, both lateral and plantar clinical pathology will be discussed in this document.

Numerous factors can contribute to the development of a tailor's bunion. Structural causes include a prominent lateral condyle, a plantarflexed fifth metatarsal, a splay foot deformity, lateral bowing of the fifth metatarsal, or a combination of these deformities (1-5). In addition, there may be hypertrophy of the soft tissues over the lateral aspect of the metatarsal head (6). Other contributing factors may include a varus fifth toe, hallux valgus with abnormal pronation of the fifth metatarsal, hindfoot varus, and flatfoot (7).

Tailor's bunion is seen most commonly in adolescents and adults. It has been reported that the mean age of presentation of tailor's bunion is 28 years (range, 16–57 years) (8), with a female-to-male ratio greater than 2:1 (1).

Address correspondence to: James L. Thomas, DPM, University of Florida, Department of Orthopaedics and Rehabilitation, 655 West 8th St, Jacksonville, FL 32209. E-mail: jlthomas@hsc.wvu.edu

[1]Chair, Jacksonville, FL; [2]Charleston, SC; [3]San Antonio, TX; [4]Scottsdale, AZ; [5]Champaign, IL; [6]Mechanicsville, VA; [7]Augusta, GA; [8]Gadsden, AL.

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Significant History (Pathway 5, Node 1)

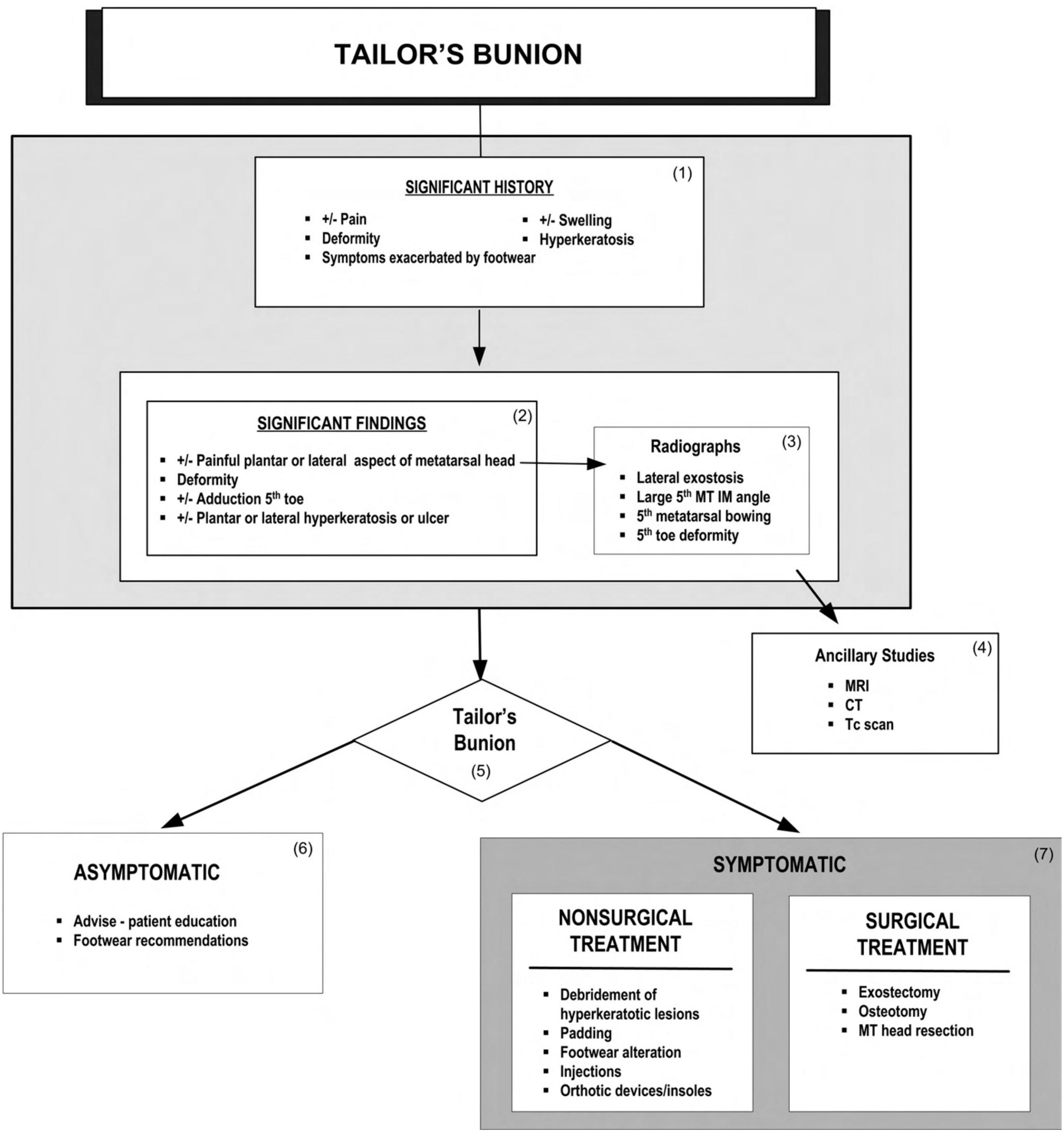
The patient with a tailor's bunion may or may not have pain related to the deformity. Patients who have symptoms may complain that they are exacerbated by footwear, as the prominence of the fifth metatarsal head results in increased pressure from shoes, leading to inflammation and pain. There also may be a history of localized swelling and/or callus formation.

Significant Findings (Pathway 5, Node 2)

The clinical examination of a patient with a tailor's bunion will reveal a lateral or plantar-lateral prominence of the fifth metatarsal head (Fig. 1). Tenderness on palpation of the lateral and/or plantar-lateral fifth metatarsal head may be associated with an overlying adventitial bursa or hyperkeratotic lesion. Adduction or adductovarus deformity of the fifth toe may be present.

Radiographic Findings (Pathway 5, Node 3)

Standard weightbearing foot radiographs to evaluate tailor's bunion include anterior-posterior, oblique, and lateral views. An increase in the fourth and fifth intermetatarsal angle usually is present (Fig. 2). The angle between the fourth and fifth metatarsal has been reported to range from 14.4° to 0.6° (average and mean values: 7.1° and 7.2°, respectively) among a standardized asymptomatic patient population (9). Bowing of the fifth metatarsal also may be revealed on radiographs. The lateral deviation angle describes the degree of lateral bowing that usually occurs at the distal third of the shaft of the fifth metatarsal. The mean normal value of this angle is 2.64° (range: 0°-7°) in patients without tailor's bunion and 8° in patients with this deformity (1). Radiographs also may reveal a lateral exostosis of the fifth metatarsal head and/or significant adduction (or adductovarus) deformity of the fifth toe.


TAILOR'S BUNION
SIGNIFICANT HISTORY
(1)
+/- Pain
Deformity
Symptoms exacerbated by footwear
+/- Swelling
Hyperkeratosis
SIGNIFICANT FINDINGS
(2)
+/- Painful plantar or lateral aspect of metatarsal head
Deformity
+/- Adduction 5th toe
+/- Plantar or lateral hyperkeratosis or ulcer
Radiographs
(3)
Lateral exostosis
Large 5th MT IM angle
5th metatarsal bowing
5th toe deformity
Ancillary Studies
(4)
MRI
CT
Tc scan
Tailor's Bunion
(5)
ASYMPTOMATIC
(6)
Advise - patient education
Footwear recommendations
SYMPTOMATIC
(7)
NONSURGICAL TREATMENT
Debridement of hyperkeratotic lesions
Padding
Footwear alteration
Injections
Orthotic devices/insoles
SURGICAL TREATMENT
Exostectomy
Osteotomy
MT head resection

PATHWAY 5

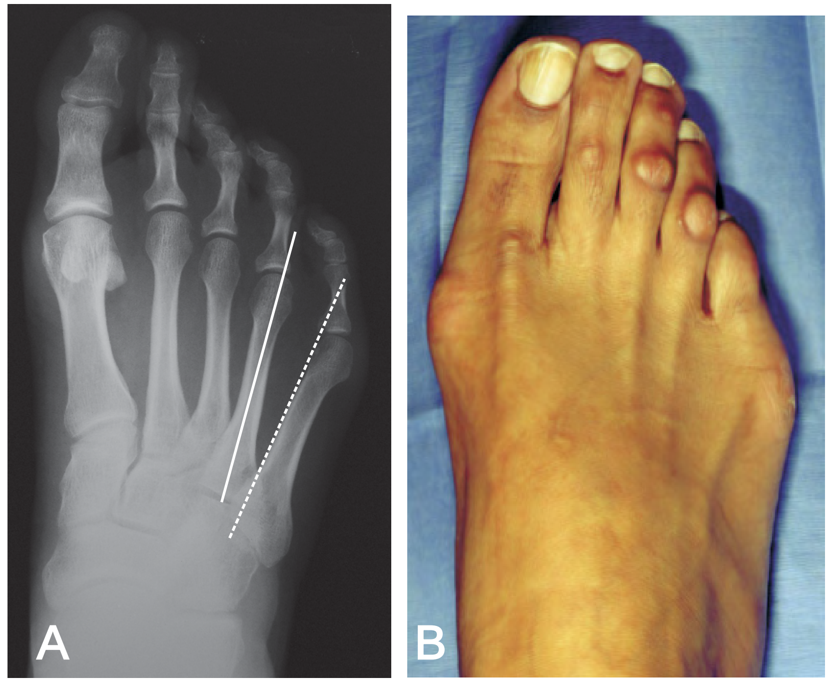


FIGURE 1 *(A)* Tailor's bunion deformity may be assessed radiographically with a lateral splaying in the distal fifth metatarsal. *(B)* Clinically, the patient generally presents with symptoms occurring laterally or plantarlaterally, often with an adduction of the fifth toe.

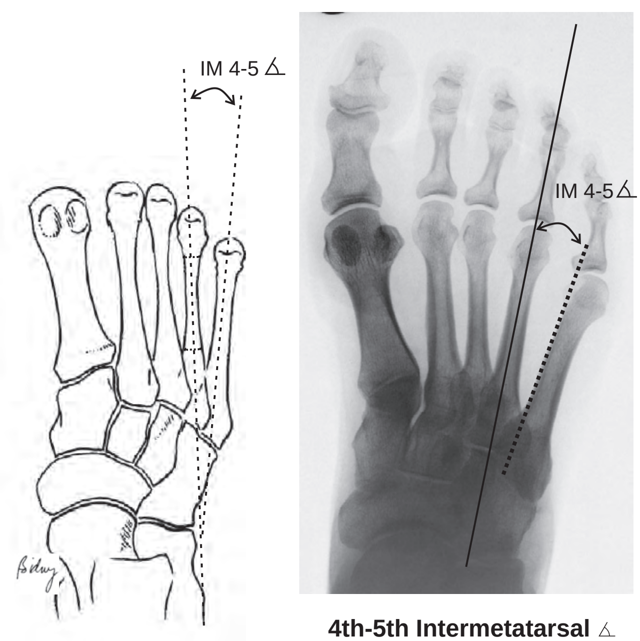


FIGURE 2 The intermetatarsal angle 4-5 may be measured with bisections of the fourth and fifth metatarsal or use of a tangent to the medial shaft of the fifth metatarsal. *(From ACFAS Scoring Scale Manual, 2006)*

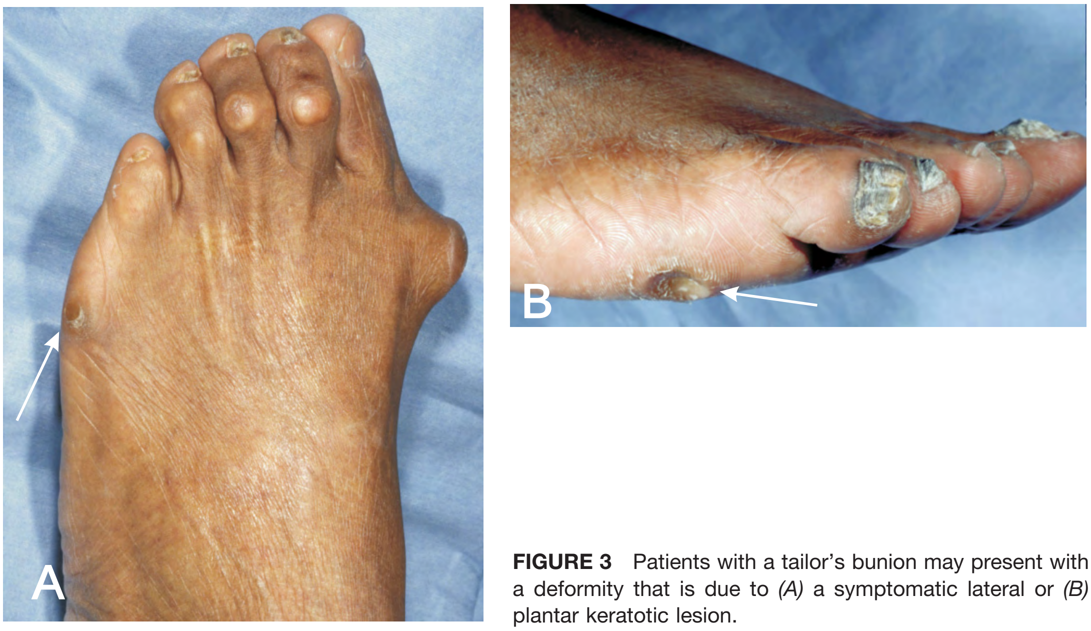


FIGURE 3 Patients with a tailor's bunion may present with a deformity that is due to *(A)* a symptomatic lateral or *(B)* plantar keratotic lesion.

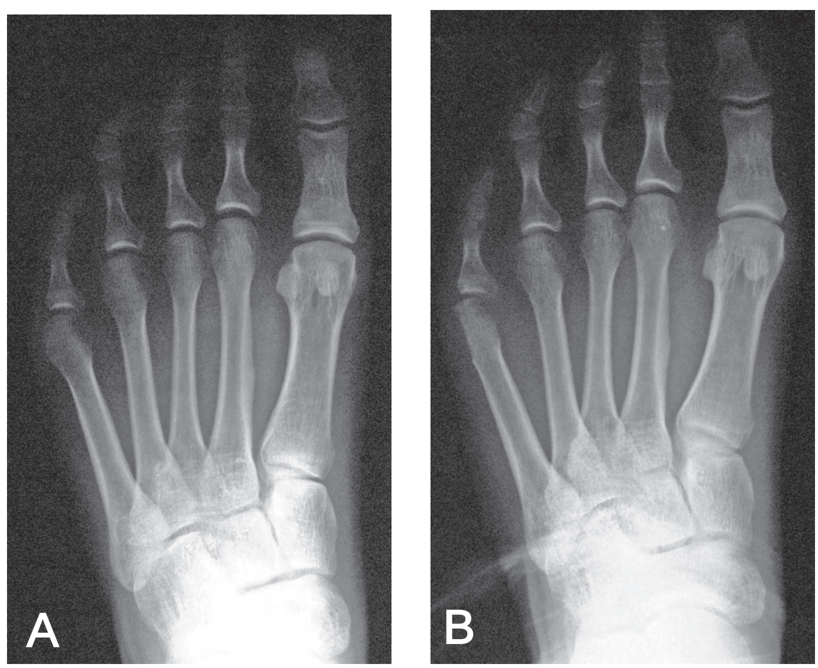


FIGURE 4 Exostectomy for tailor's bunion has been used, but it is associated with recurrent deformity and continued adduction of the fifth toe, as seen on these *(A)* presurgical and *(B)* postsurgical radiographs.

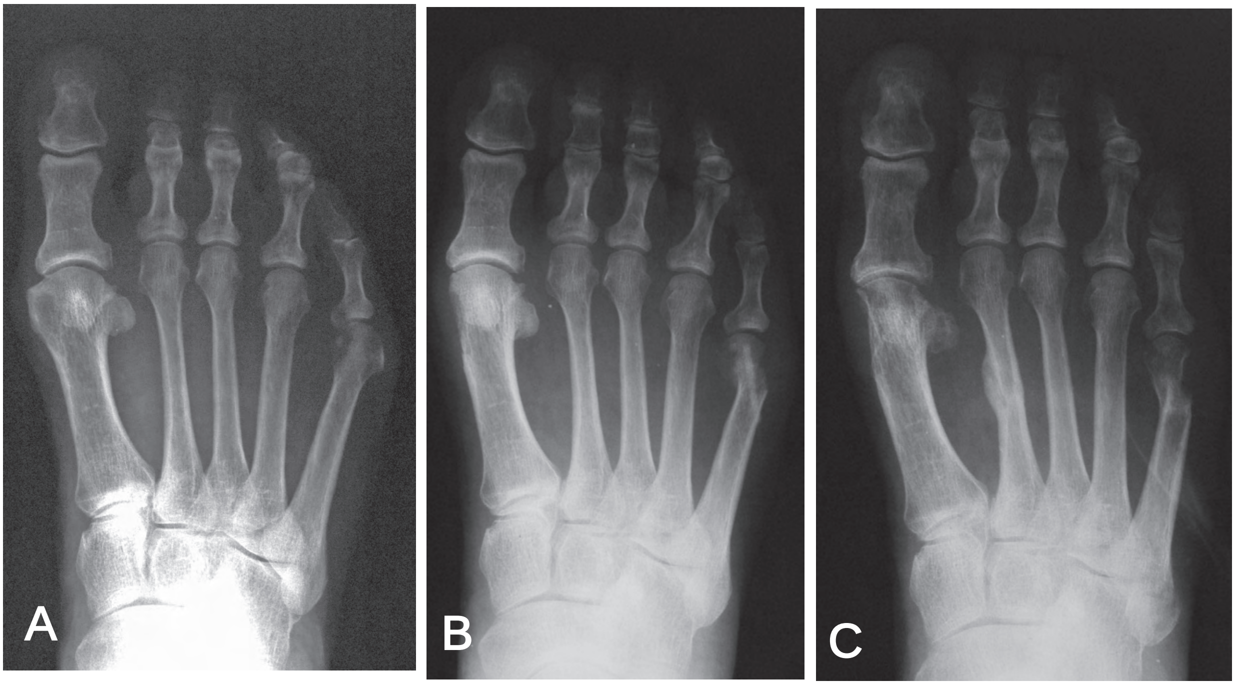


FIGURE 5 *(A)* Tailor's bunion deformity generally is addressed with some type of osteotomy. *(B)* This illustrates a distal type of medial displacement osteotomy at 2 weeks postsurgery and *(C)* at 3 months postsurgery.

Optional Ancillary Studies (Pathway 5, Node 4)

Ancillary studies rarely are necessary to evaluate a tailor's bunion deformity. When indicated, ancillary studies may include magnetic resonance imaging (MRI), computed tomography (CT), and technetium bone scan (10, 11).

Diagnosis (Pathway 5, Node 5)

The diagnosis of tailor's bunion is predominantly a clinical one. However, radiographic findings, in particular, may be very helpful in the assessment of the exact nature of the deformity and contributory structural pathology.

Asymptomatic Tailor's Bunion (Pathway 5, Node 6)

The asymptomatic patient with a tailor's bunion deformity should be provided with patient education addressing the etiology of the condition and prevention of future symptoms. In particular, the patient should be given recommendations regarding proper footwear.

Symptomatic Tailor's Bunion (Pathway 5, Node 7)

Nonsurgical treatment of tailor's bunion deformity is centered on alleviating pressure and irritation over the fifth metatarsal head. This may be accomplished by footwear modifications and/or padding as well as debridement of associated hyperkeratotic lesions (Fig. 3). If an inflamed bursa is present, injection therapy may be indicated. Orthoses and padded insoles also may be beneficial in offloading the symptomatic area or in treating associated hindfoot varus or flatfoot deformity. Anti-inflammatory medication also may be used (12).

Surgical treatment is indicated for patients who have failed nonsurgical care and patients who are not candidates for nonsurgical care. The goal of surgical treatment is to decrease the prominence of the fifth metatarsal laterally. Selection of the surgical procedure is based on the physical evaluation and radiographic assessment. Surgical correction to alleviate the pain at the bone prominence varies from exostectomy (Fig. 4) to differing types of osteotomies (3, 13-23) (Fig. 5). Resection of the fifth metatarsal head for treatment of tailor's bunion generally is indicated for salvage conditions or in the presence of unreconstructable deformities (12, 24) (Fig. 6).

In summary, tailor's bunion is an inherited, progressive deformity that is frequently associated with certain foot types, aggravated by footwear, and painful when wearing normal shoes. Although nonsurgical measures may be used initially to reduce the symptomatology associated with this deformity, surgical repair is often necessary.

FIGURE 6 This patient with an undercorrected adult clubfoot presented with a plantar lateral skin lesion and pain. Shown are presurgical *(A)* dorsoplantar and *(B)* lateral radiographs. *(C)* This dorsoplantar radiograph illustrates fifth metatarsal head resection and stabilization of the fifth ray with a kirschner wire.

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Diagnosis and Treatment of Forefoot Disorders. Section 5. Trauma

Clinical Practice Guideline Forefoot Disorders Panel: James L. Thomas, DPM,[1] Edwin L. Blitch, IV, DPM,[2] D. Martin Chaney, DPM,[3] Kris A. Dinucci, DPM,[4] Kimberly Eickmeier, DPM,[5] Laurence G. Rubin, DPM,[6] Mickey D. Stapp, DPM,[7] and John V. Vanore, DPM[8]

This clinical practice guideline (CPG) is based upon consensus of current clinical practice and review of the clinical literature. The guideline was developed by the Clinical Practice Guideline Forefoot Disorders Panel of the American College of Foot and Ankle Surgeons. The guideline and references annotate each node of the corresponding pathways.

Trauma (Pathway 6)

Trauma in the forefoot can range from simple, nondisplaced fractures to limb-threatening injuries. Proper evaluation and diagnosis is critical to determine the extent of injury and appropriate treatment.

Significant History (Pathway 6, Node 1)

Trauma to the toes, lesser metatarsals, and their respective joints involves various mechanisms and injury types (1, 2). These include a history of both direct and indirect trauma. Patients may exhibit symptoms acutely at the time of trauma or at a later onset. Symptoms include pain, swelling, discoloration, loss of joint motion, and difficulty standing and/or walking. An accurate history of the inciting traumatic event should be elicited.

Significant Findings (Pathway 6, Node 2)

Clinical examination of the traumatized forefoot may show pain upon palpation and motion of affected joints. The patient may have decreased range of motion, with or without tendon dysfunction. Deformity may or may not be present. The patient may experience pain with or without weightbearing. Soft tissue damage must be evaluated and any neurovascular compromise recognized. Edema is common and often does not allow a shoe to be worn. Ecchymosis and/or erythema may be present, depending on the injury type.

Radiographic Findings (Pathway 5, Node 3)

Radiographs are indicated in most cases of trauma to the forefoot to rule out fracture and/or joint dislocation. Anterior-posterior, lateral, and oblique views may be obtained with the patient in either a weightbearing or nonweightbearing position. In some cases, stress views under anesthesia may be required to identify the injuries.

Positive Diagnosis for Fracture or Dislocation (Pathway 6, Node 4)

Fractures should be evaluated and treated appropriately. Special attention should be directed to restoring articular congruity and segmental alignment, paying particular attention to maintaining alignment in the sagittal plane. Nondisplaced fractures of the forefoot may require only appropriate immobilization (Fig. 1), whereas displaced fractures may require closed or open reduction techniques (3-5) (Figs. 2 and 3). Of special note are fractures of the proximal diaphyseal area of the fifth metatarsal (Jones fracture) (6-8) (Fig. 4). Although many fractures of this type may be treated with immobilization and avoidance of weightbearing, internal fixation may be indicated in some patient populations (eg, high-caliber athletes) (9-26). Significant intra-articular injury of the interphalangeal or metatarsophalangeal joint may require subsequent arthroplasty.

Dislocations of the interphalangeal joints of the lesser toes probably are somewhat more common than dislocations of the metatarsophalangeal joint. Traumatic disloca-

Address correspondence to: James L. Thomas, DPM, University of Florida, Department of Orthopaedics and Rehabilitation, 655 West 8th St, Jacksonville, FL 32209. E-mail: jlthomas@hsc.wvu.edu
[1]Chair, Jacksonville, FL; [2]Charleston, SC; [3]San Antonio, TX; [4]Scottsdale, AZ; [5]Champaign, IL; [6]Mechanicsville, VA; [7]Augusta, GA; [8]Gadsden, AL.

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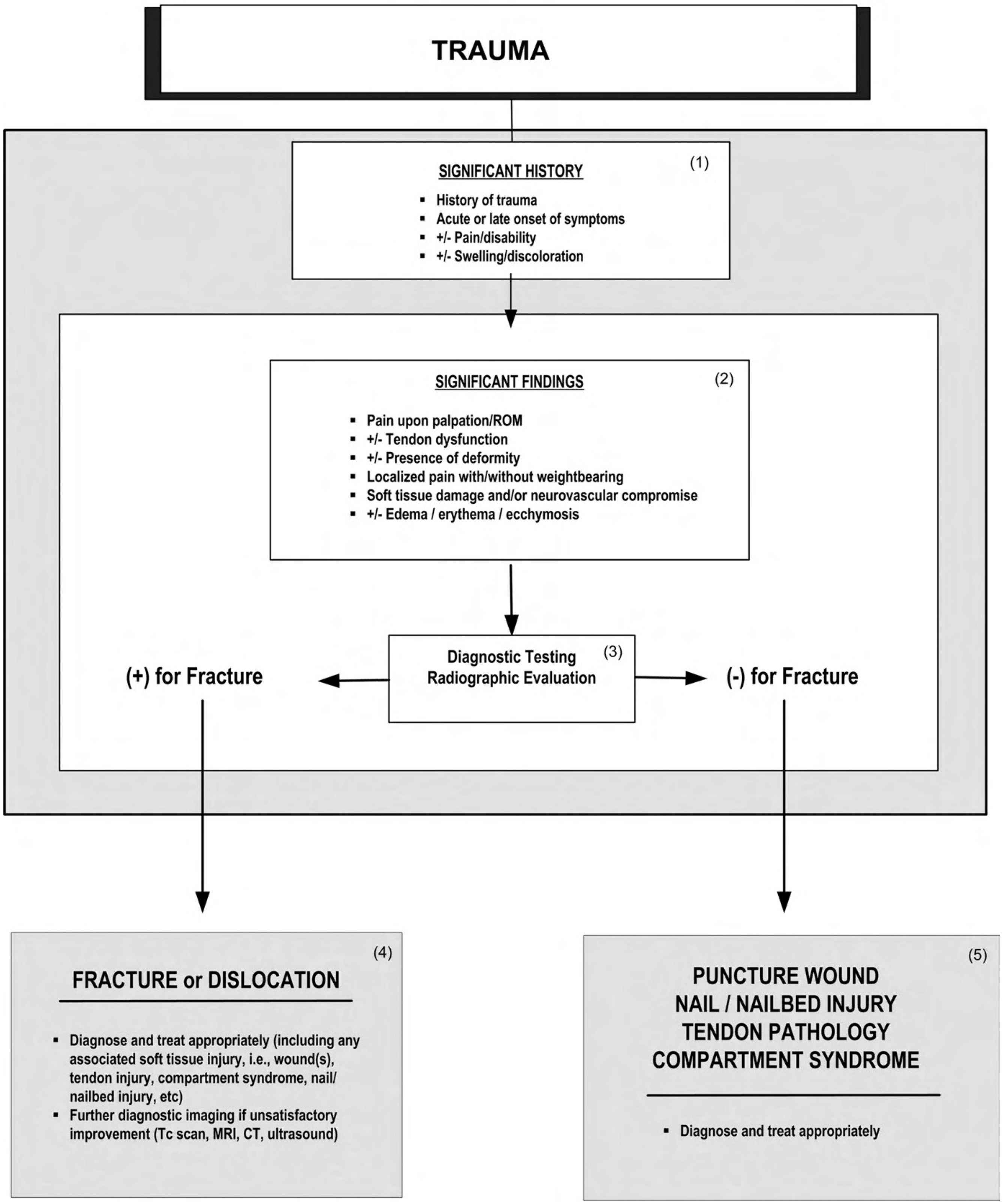
TRAUMA
SIGNIFICANT HISTORY
(1)
History of trauma
Acute or late onset of symptoms
+/- Pain/disability
+/- Swelling/discoloration
SIGNIFICANT FINDINGS
(2)
Pain upon palpation/ROM
+/- Tendon dysfunction
+/- Presence of deformity
Localized pain with/without weightbearing
Soft tissue damage and/or neurovascular compromise
+/- Edema / erythema / ecchymosis
Diagnostic Testing
Radiographic Evaluation
(3)
(+) for Fracture
(-) for Fracture
(4)
FRACTURE or DISLOCATION
Diagnose and treat appropriately (including any associated soft tissue injury, i.e., wound(s), tendon injury, compartment syndrome, nail/ nailbed injury, etc)
Further diagnostic imaging if unsatisfactory improvement (Tc scan, MRI, CT, ultrasound)
(5)
PUNCTURE WOUND
NAIL / NAILBED INJURY
TENDON PATHOLOGY
COMPARTMENT SYNDROME
Diagnose and treat appropriately

PATHWAY 6

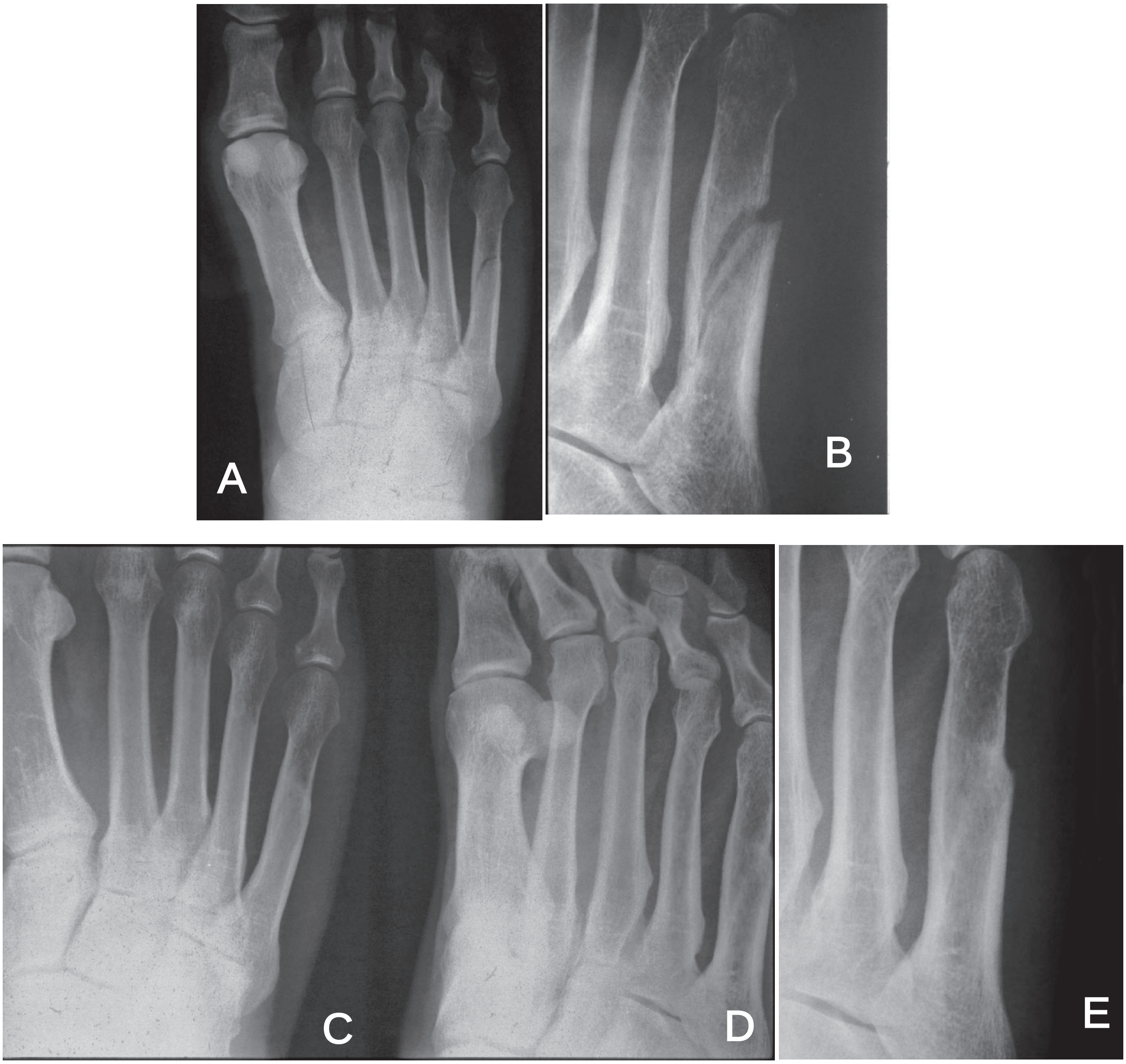

FIGURE 1 Fifth metatarsal fractures are not uncommon. This spiral oblique fracture visualized on *(A)* anteroposterior and *(B)* oblique radiographs was treated nonsurgically with immobilization. *(C, D, and E)* Gradual progression to bony union and good alignment is shown in these radiographs.

tions most often occur in the dorsal direction or in the transverse plane. Acute treatment focuses on reduction of the joint dislocation, which usually can be accomplished in a closed fashion (Fig. 5). In some cases, soft tissue interposition may require open reduction. Late repair and balancing of capsuloligamentous tissues rarely is necessary.

Diagnosis and treatment of any concomitant soft tissue injury (eg, soft tissue wound, tendon injury, compartment syndrome) are carried out appropriately. If clinical improvement is not seen within the expected timeframe, further diagnostic imaging such as technetium bone scan, magnetic resonance imaging (MRI), computed tomography (CT), or ultrasound may be indicated to evaluate for non-union or unrecognized osseous or soft tissue injury.

Negative Diagnosis for Fracture or Dislocation (Pathway 6, Node 5)

Trauma to the forefoot is always associated with a degree of soft tissue injury (27). This may include a variety of soft tissue conditions.

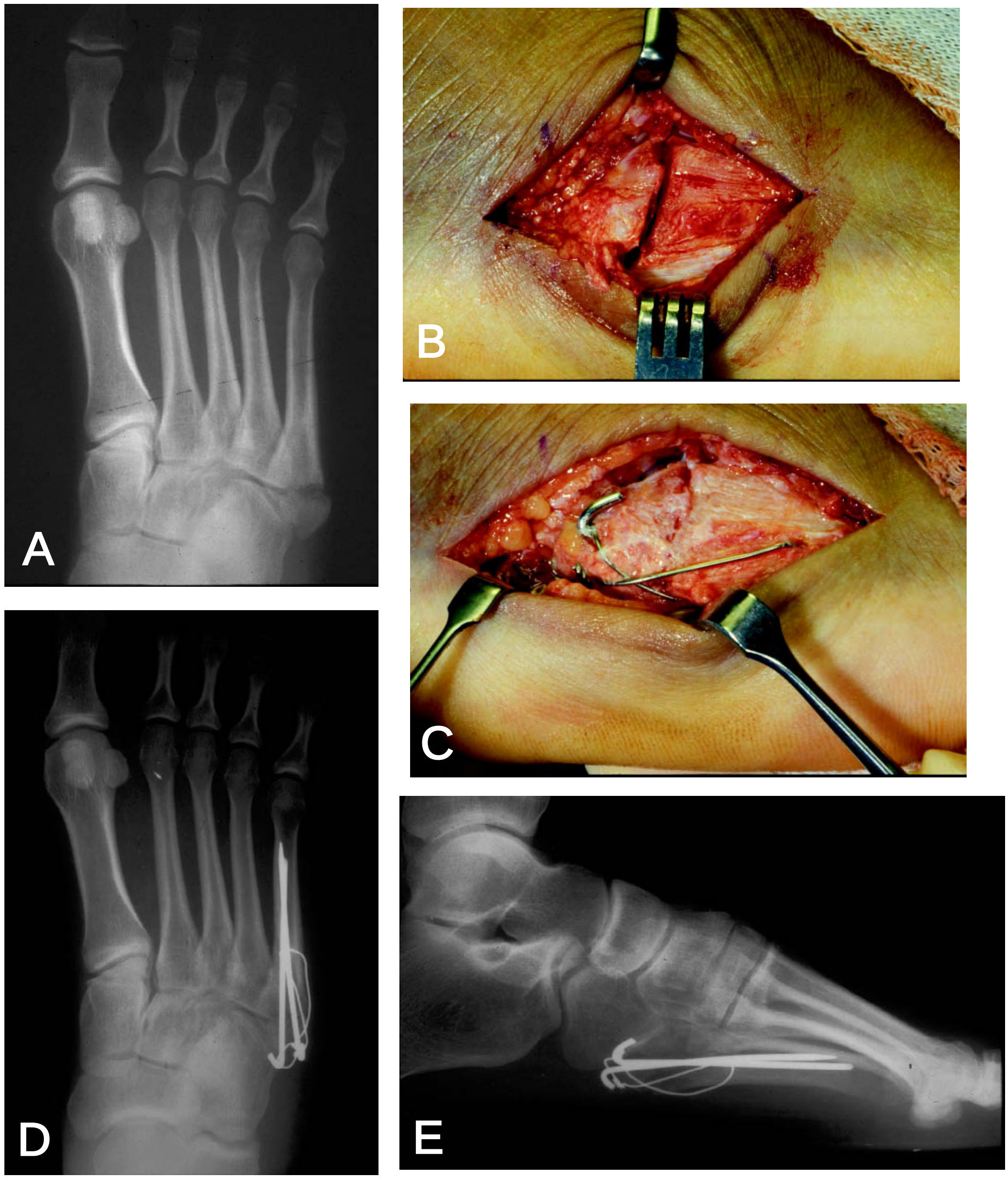

FIGURE 2 The fifth metatarsal base avulsion fracture is visualized on this *(A)* radiograph and *(B)* intraoperative photograph. The patient underwent open reduction–internal fixation with tension-banding of the fracture, as shown in the *(D)* intraoperative view and on postsurgical *(E)* anteroposterior and *(F)* lateral radiographs.

Puncture wounds of the foot are not uncommon and may or may not be associated with a retained foreign body (28, 29). Appropriate wound care must be performed acutely, along with assurance of updated tetanus prophylaxis (30-42). When seen subacutely, puncture wounds may present with signs and symptoms of infection, necessitating more aggressive incision and drainage as well as indicated laboratory testing. Further diagnostic imaging such as MRI and ultrasound may be indicated to identify a suspected retained foreign body not revealed on radiographic studies (43-47).

Nail and nail bed injuries range from simple subungual hematoma to open fracture with tissue loss. Approximately one fourth of injuries with subungual hematomas also have fractures of the distal phalanx (48-50). Nailbed lacerations frequently are associated with subungual hematomas. Simple nail bed lacerations can be irrigated and sutured with absorbable sutures (51). A nail bed laceration associated with a fracture of the distal phalanx is technically an open fracture and should be treated accordingly. Degloving injuries involving the nail and distal phalanx can be treated with resection of bone to a

FIGURE 3 This patient suffered an injury with fracture of the third and fourth metatarsals. *(A)* anteroposterior and *(B)* oblique radiographs show lateral displacement. The patient underwent open reduction–internal fixation with kirschner wire stabilization illustrated by *(C)* anteroposterior and *(D)* lateral postoperative radiographs.

proximal level, which allows for adequate soft tissue coverage (52).

Tendon disruption occurs most commonly with laceration and rarely with closed injury (Fig. 6). The majority of cases of extensor hallucis longus (especially proximal to the hood apparatus) and flexor hallucis longus disruption are treated with open repair of the tendon (53). The literature is less clear regarding the treatment of

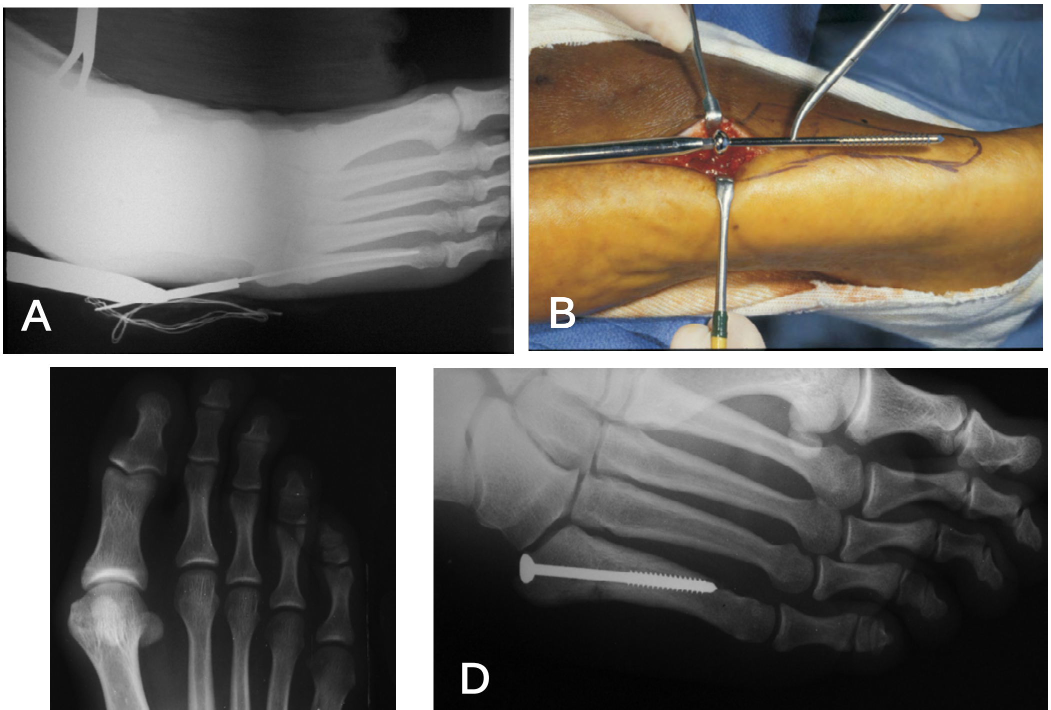

FIGURE 4 The proximal fifth metatarsal fracture or Jones fracture has a poor prognosis compared with the avulsion fracture. This patient underwent open reduction–internal fixation with a axial screw through the tuberosity. *(A)* Intraoperative radiography and *(B)* clinical presentation illustrate screw orientation down medullary canal. *(C)* anteroposterior and *(D)* oblique radiographs show final screw placement.

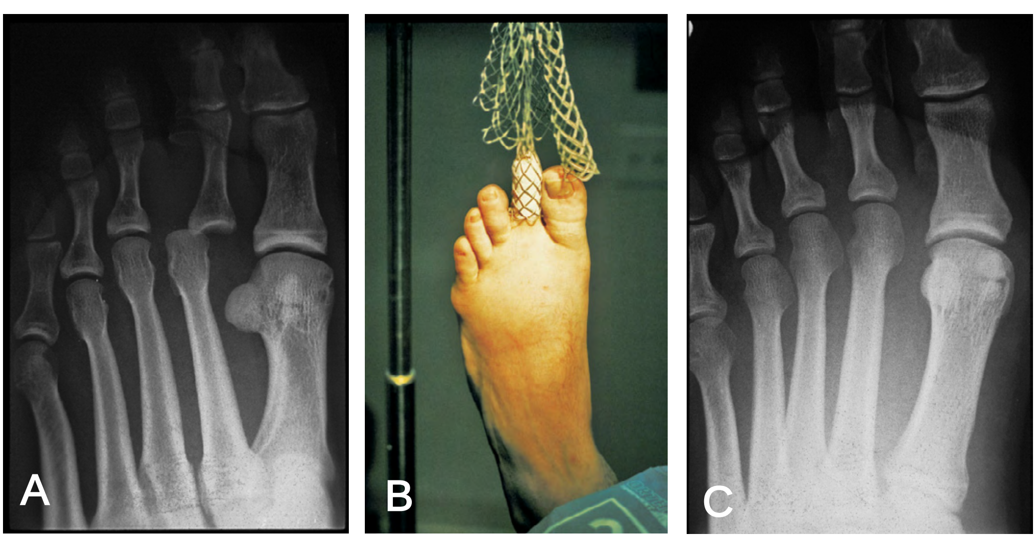

FIGURE 5 *(A)* MPJ dislocations occur, and this radiograph shows the displacement. *(B)* Closed reduction was performed in a Chinese finger-trap, with gravity reduction providing an (C) anatomic alignment.

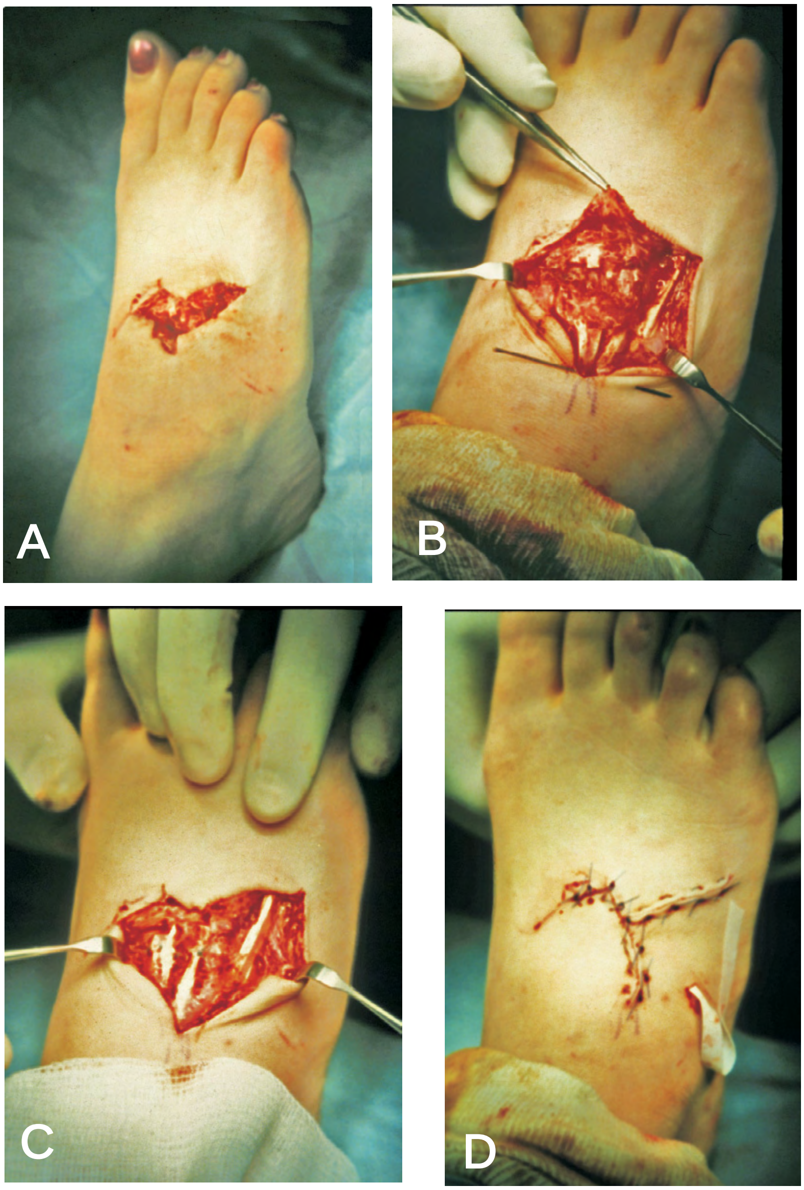

FIGURE 6 *(A)* Intraoperative view of patient who suffered laceration of dorsum of foot with severing of her extensor tendons. Intraoperative views show *(B)* transected tendons, *(C)* subsequent repair, and *(D)* final wound closure.

extensor digitorum longus and flexor digitorum longus disruption.

The attention and care given to the soft tissue envelope is an integral part of the evaluation and management of any forefoot injury. High-energy and crush injuries should raise the level of suspicion for compartment syndrome (54, 55). Clinical signs include digital weakness or paralysis, gross edema, tense compartments, parasthesias, mottled skin, and unrelieved pain (51, 56). Compartment pressures of the foot above 30 mm Hg to 35 mm Hg are diagnostic for compartment syndrome (57). Surgical decompression is indicated if compartment syndrome is suspected from clinical findings and/or compartment pressures (58-60).

Lacerations, abrasions, and degloving injuries also may involve the forefoot (61). Evaluation for associated neurovascular compromise, tendon injury, and other injuries must be performed.

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