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Preface: Management of Metatarsalgia and Lesser Toe Deformities **xv**

Todd A. Irwin

Anatomy and Physiology of the Lesser Metatarsophalangeal Joints **1**

Fred T. Finney, Ezequiel Cata, James R. Holmes, and Paul G. Talusan

Knowledge and command of anatomy is paramount to effectively treating disorders of the lesser metatarsophalangeal (MTP) joints. The osseous structures consist of the proximal phalanx of the toe and the metatarsal head. The soft tissues on the dorsum of the MTP joint include the joint capsule and the tendons of extensor digitorum longus and extensor digitorum brevis. The proper and accessory collateral ligaments form the medial and lateral walls and contribute to stability in the coronal and sagittal planes. The plantar plate forms the plantar border of the MTP joint and stabilizes the MTP joint against hyperextension and dorsal translation.

Conservative Management of Metatarsalgia and Lesser Toe Deformities **9**

Andrew E. Federer, David M. Tainter, Samuel B. Adams, and
Karl M. Schweitzer Jr

There are several forefoot conditions that can result in metatarsal head pain. Various points of the gait cycle can predispose the metatarsal heads to pain based on intrinsic and extrinsic imbalances. Metatarsalgia can further be classified according to primary, secondary, or iatrogenic etiologies. Within these groups, conservative management is the first line of treatment and can often obviate surgical intervention. Depending on the cause of pain, proper footwear, orthoses, and inserts coupled with targeted physical therapy can alleviate most symptoms of metatarsalgia and lesser toe deformities.

Treatment of Metatarsalgia with Distal Osteotomies **21**

David Redfern

Many different distal metatarsal osteotomies have been described in the surgical treatment of metatarsalgia. The surgeon should use such osteotomies judiciously, and indeed, in the author's experience, they are infrequently required and are certainly not a first port of call. In cases in which nonoperative treatments have failed, a thorough understanding of the causes of metatarsalgia and a detailed clinical assessment of the patient are essential if good surgical outcomes are to be achieved. If using distal metatarsal osteotomies as part of the surgical plan, then the author favors extraarticular percutaneous osteotomies to minimize postoperative stiffness.

Treatment of Metatarsalgia with Proximal Osteotomies **35**

Emily C. Vafek and Simon Lee

Metatarsalgia is among the most common sources of forefoot pain. Proximal metatarsal osteotomies are an important technique in the armamentarium of the surgeon treating metatarsalgia that has failed nonoperative

management. Proximal osteotomies can provide powerful deformity correction with precise control to both shorten and elevate the metatarsal head. However, they can be technically challenging, difficult to attain satisfactory fixation, require increased postoperative immobilization, and can result in transfer lesions. There are numerous described techniques with little supporting evidence, and more research is needed to establish the optimal procedure to reliably alleviate patient's symptoms while minimizing complications.

Metatarsal Osteotomies: Complications

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Veerabhadra "Babu" Reddy

Metatarsal osteotomies can be divided into proximal and distal. The proximal osteotomies, such as the oblique, segmental, set cut, and Barouk-Rippstein-Toullec osteotomy, all provide the ability to significantly change the position of the metatarsal head without violating the joint. These osteotomies, however, have a high rate of nonunion when done without internal fixation and can lead to transfer metatarsalgia when done without regard to the parabola of metatarsal head position. Distal osteotomies such as the Weil and Helal offer superior healing but have an increased incidence of recurrent metatarsalgia, joint stiffness, and floating toe.

Gastrocnemius Recession for Metatarsalgia

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Rose E. Cortina, Brandon L. Morris, and Bryan G. Vopat

Metatarsalgia is a common cause of plantar forefoot pain. Causes of metatarsalgia include foot anatomy, gait mechanics, and foot and ankle deformity. One specific cause, mechanical metatarsalgia, occurs because of gastrocnemius muscle contracture, which overloads the forefoot. Muscular imbalance of the gastrocnemius complex alters gait mechanics, which increases recruitment of the toe extensor musculature, thereby altering forefoot pressure. Patients with concomitant metatarsalgia and gastrocnemius contracture demonstrate ankle equinus and a positive Silfverskiöld test. Nonoperative therapeutic modalities are mainstays of treatment. In patients in whom these treatments fail to provide metatarsalgia symptomatic relief, gastrocnemius muscle lengthening is a therapeutic option.

Treatment of Flexible Lesser Toe Deformities

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Solenne Frey-Ollivier, Fernanda Catena, Marianne Hélix-Giordanino, and Barbara Piclet-Legré

Lesser toe deformities are among the most common complaints presented to foot and ankle specialists. These deformities present in variable ways, which makes surgical decision making complex. For every type of deformity, there could be a combination of soft tissues and bony procedures, chosen according to the surgeon's preferences. This article first describes the modern classification of lesser toe deformities and then presents the different treatments and procedures available for those flexible deformities. In addition, this article proposes an algorithm based on clinical/radiologic evaluation and step-by-step surgical decision making.

Treatment of Rigid Hammer-Toe Deformity: Permanent Versus Removable Implant Selection 91

Jesse F. Doty and Jason A. Fogleman

Hammer-toe deformities that fail nonoperative treatment can be successfully addressed with proximal interphalangeal joint resection arthroplasty or fusion. The goal of surgery is to eliminate the deformity and rigidly fix the toe in a well-aligned position. Hammer-toe correction procedures can be performed with temporary Kirschner wire (K-wire) fixation for 3 to 6 weeks with high success rates. Pain relief with successful hammer-toe correction approaches 90%; patient satisfaction rates approximate 84%. Although complication rates are rare in most series, there remains a concern regarding exposed temporary K-wire fixation, which has led to the development of multiple permanent internal fixation options.

Lesser Metatarsophalangeal Joint Instability: Treatment with Tendon Transfers 103

Caio Nery and Daniel Baumfeld

Complex digital deformities and metatarsophalangeal joint instability encompass a wide range of pathology, and one must identify the different degrees of ligamentous disruption. It is important to address a combination of procedures to treat gross deformities of the lesser toes. Surgical treatment should be individualized and requires a sequential process for adequate reduction and deformity correction. There is no gold standard procedure for every deformity. Although residual stiffness can result from tendon transfer, overall patient satisfaction levels remain high when it is performed under the proper indications and concomitantly with other procedures to gain full correction of these challenging deformities.

Lesser Metatarsophalangeal Joint Instability: Advancements in Plantar Plate Reconstruction 127

Raymond Y. Hsu, Alexej Barg, and Florian Nickisch

The plantar plate and associated collateral ligaments are the main stabilizers of each of the lesser metatarsophalangeal joints. Although clinical examination and plain radiographs are usually sufficient to establish the diagnosis of a plantar plate tear, MRI or fluoroscopic arthrograms may help in specific cases. Recent results with a dorsal approach to plantar plate repair are promising with respect to pain relief and patient satisfaction.

Managing Complications of Lesser Toe and Metatarsophalangeal Joint Surgery 145

Phinit Phisitkul

The anatomy of the lesser toes is highly complicated and not yet well understood. The high propensity of the metatarsophalangeal joint to develop hyperextension deformity should be recognized. Surgeons should provide each patient with a realistic expectation for lesser toe reconstructive procedures. A successful surgical result requires a well-planned procedure, accurate execution using proper techniques, and meticulous postoperative care. When complications occur, surgeons should identify culprits so that proper treatment strategies can be successfully executed. This article discusses a wide array of tactics to manage common complications in lesser toe surgery.

Treatment of Freiberg Disease**157**

Jeffrey D. Seybold and Jacob R. Zide

Freiberg disease, or osteochondrosis of the lesser metatarsal head, usually involves the second metatarsal and presents during the second or third decade of life. Conservative measures to relieve pressure on the affected metatarsal head are the first-line treatments, with good success for Smillie stage I to III disease. Operative treatments are divided into joint-preserving and joint-reconstructing procedures. Although multiple case series describe success with numerous techniques, there are no established guidelines for treatment. All surgical techniques carry a risk of a stiff or floating toe and transfer metatarsalgia. This article reviews the current surgical treatment options for Freiberg disease.