**Surgical Management of Foot and Toe Deformities**

- Podiatric foot and ankle surgeons at the Penn Medicine Division of Plastic Surgery are performing metatarsal osteotomies, digital arthrodesis and other surgeries to correct digital osseous deformities caused by bunion (hallux valgus) and hammertoe.

Bunion and hammertoe are progressive, painful and debilitating disorders that affect the toes and forefoot, both of which are essential to normal balance, gait, kinetics and ambulation. Both conditions are associated with significant musculoskeletal pain and sequelae, including callosity, distortion of ligament and tendon function, bone compression and tissue atrophy. Both are also a source of great cosmetic concern.

At the Penn Medicine Division of Plastic Surgery, treatment for foot deformities is defined by the extent of the disorder and the needs, expectations and commitment of the patient. In general, >90% of bunion and hammertoe treatments within the Division achieve the objectives of improved cosmesis and function and significant reduction in pain and disability.

For patients with bunions and hammertoes, a problem-focused examination is performed to evaluate the extent of digital deformity. Examination must include assessment of the circulatory status of the lower extremity. Early stage disorders of the foot are treated nonsurgically with shoewear designed to prevent the progression of bunions or hammertoe. These include lower heeled and support shoes, and wider orthopaedic shoes with orthotic spacers to align the toes. Other devices, including foot and toe splints and gel orthotics customized to the foot, can be effective, as well.

Patients with advanced bunions or hammertoe are candidates for corrective surgery at Penn. The appropriateness of surgery is determined by a thorough evaluation of the patient’s overall health followed by assessment of the circulatory status of the lower extremity. Poor circulation (or poor health) may eliminate the patient as a surgical candidate.

A weight-bearing radiograph and a problem-focused physical examination are essential to evaluate the magnitude of digital osseous deformity. The x-ray is used preoperatively to determine the angle and distance of displacement for the metatarsal head and the amount of movement needed for its correction.

Surgery for advanced bunions at Penn include bunionectomy and distal or proximal osteotomy with realignment of the metatarsal. Hammertoes that do not respond to nonsurgical treatments are treated with resection arthroplasty. In patients with deformity of the proximal phalangeal joint in the transverse plane, a neuromuscular etiology for foot deformity, or recurrence of bunion or hammer toes, arthrodesis (fusion) is the recommended treatment. Fusion often involves screw, plate and/or K wire fixation.

**Case Study**

Mrs. B, a 37-year-old, was referred to the Penn Medicine Division of Plastic Surgery for a podiatric foot and ankle surgery evaluation of long-term, chronic pain and distress from a left foot bunion. Mrs. B was otherwise healthy, of normal weight, with no history of osteoarthritis or neuromuscular disease. Her bunion had progressed over many years despite a variety of conservative treatments, including orthotic shoes, toe splints, bunion shields, activity modification and anti-inflammatory medications.

At Penn, weight-bearing x-rays confirmed that Mrs. B had flat feet and a lateral displacement of her left 1st metatarsal resulting in a hallux valgus angle (HVA) of >30° degrees (normal HVA <15°), as well as substantial bony overgrowth at the bursa (see Figure 1), corns and callus formation. Pulse palpation, capillary refill and other tests determined that her vascularity was sound.

After a consultation during which the risks of surgery (including but not limited to persistent pain and recurrence) were provided in detail, Mrs. B agreed to have bunionectomy surgery.

At the initiation of surgery, a pneumatic mid-thigh tourniquet was placed to create a bloodless operative field. An 8 cm curvilinear incision was then made from the dorsal aspect of the base of the proximal phalanx of the hallux extending to the first metatarsocuneiform joint. All vital neurovascular structures were retracted from the surgical field and subcutaneous tissues bluntly reflected from the medial aspect of the first metatarsophalangeal joint capsule. At the first intermetatarsal space, the extensor expansion was identified and incised and the adductor hallucis tendon freed from its attachments at the base of the proximal phalanx of the hallux and fibular sesamoid. A small segment of the tendon was excised to prevent its reattachment. The fibular sesamoidal ligament was then identified and incised, allowing the sesamoid apparatus to be mobilized.

An inverted L capsulotomy was then performed in the first metatarsophalangeal joint capsule. The capsular attachments to the medial aspect of the first metatarsal head were freed, exposing a severe bunion deformity. The joint was found to have mild-to-moderate degenerative disease, especially along the medial aspect of the joint complex, erosions and denudation of the articular cartilage were also noted.

![Figure 1](image.png)

**Figure 1:** Left: Bunion on the left 1st metatarsal, displaying lateral displacement and bony overgrowth at the bursa. Right: Following bunionectomy surgery. Note the substantial reduction of the first intermetatarsal angle with complete correction of bunion deformity.

(Case study continued on back page)
The prominent medial eminence of the first metatarsal head was resected, taking care to preserve the plantar medial sagittal groove, which was smoothed to a normal contour.

Following exposure of the first metatarsocuneiform joint with minimal periosteal stripping, the articular surfaces and subchondral bone from the first metatarsal base and the distal aspect of the medial cuneiform were resected in a wedge fashion to reduce the first intermetatarsal angle. The contiguous surfaces of the first metatarsal base and distal medial cuneiform were then fenestrated with a 0.045-inch K-wire, and the arthrodesis site completely reduced and translated 2mm plantarly to compensate for shortening.

Temporary guidewire was placed across the arthrodesis site, 2 cm from the joint just lateral to midline of the first metatarsal and into the medial cuneiform from distal to plantar proximal direction. A second K-wire was then used to stabilize the first metatarsal in the sagittal plane. Partially threaded cannulated Wright Medical Technology screws were then inserted over the guidewires in the standard AO fashion to obtain compression of the arthrodesis site. Intraoperative fluoroscopy (OF) confirmed stability and apposition of the first metatarsocuneiform joint arthrodesis site in all three planes. The temporary guidewires were then removed.

A subsequent OF demonstrated excellent reduction of the first intermetatarsal angle (where the first ray was in complete rectus alignment) and complete correction of Mrs. B's previous bunion deformity with no further hypermobility of the first metatarsal cuneiform joint complex noted under stress examination.

The prominent dorsal exostosis of the 1st metatarsocuneiform joint was burred to a normal contour. The wound was flushed with copious amounts of normal sterile saline. The pneumatic mid thigh tourniquet was deflated and excellent hemostasis obtained and closure was initiated.

The redundant medial capsule of the first metatarsophalangeal joint was excised to create a medial capsulorrhaphy and further closed with #2-0 Vicryl. The extensor tendons were relocated within along the axis of the 1st ray. The subcutaneous tissues and deep fascia were then reaproximated with #5-0 Vicryl in a running subcuticular fashion. Sterile Steri-Strips were applied along with sterile dressing and a below the knee cast, well padded to all bony tuberosities with the left foot at 90 degrees to the leg.

Mrs. B was discharged home the day after her surgery in her cast, which she wore for six weeks. During this time she began physical therapy. At six weeks, the appearance of her foot was approximately that of a foot unaffected by bunion (Figure 2). Mrs. B was placed in a protective boot and began range of motion and early strengthening exercises. By her six month post-operative follow-up visit, she had progressed to full weight bearing.

Figure 2: Photo at 12 weeks following bunionectomy with wedge osteotomy.

Faculty Team
The Penn Medicine Division of Plastic Surgery also houses the Penn Center for Wound Healing and Reconstruction, a comprehensive center for advanced healing and full body reconstruction that brings together surgeons and clinician specialists from plastic surgery, podiatric surgery, foot and ankle surgery, vascular medicine and surgery, microsurgery, interventional cardiology, infectious disease, hyperbaric medicine, endocrinology, and orthotics and prosthetics.

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