CHAPTER **27**

THE PANMETATARSAL HEAD RESECTION TECHNICAL PRINCIPLES AND CONSIDERATIONS

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The general technique of panmetatarsal head resection dates to 1911 when Hoffman used the procedure to address the severely dislocated rheumatoid forefoot.[1] Since this initial description, several modifications have been presented that have added to the effectiveness of the procedure and allowed the indications to be expanded. Due to its ability to remove deformity and reestablish a functional range of motion at the metatarsophalangeal joint level, the procedure is now used to address a variety of forefoot anomalies. Current indications include severe arthritic conditions (both inflammatory and degenerative), diabetic Charcot or ulcer disease, a variety of nerve entrapment syndromes, as well as traumatically and iatrogenically created forefoot deformities.

This paper will present the technique as it is know today and, when appropriate, discuss alternatives and options. The procedure will be described and illustrated in stages that correspond to the various anatomic levels of dissection: incision placement, tendon and capsule considerations, osseous resection, digital stabilization, and first ray alternatives. Considerations in postoperative management will also be discussed. As the technical advances are discussed, it is important to keep in mind the four goals of the procedure: 1. Remove obvious deformities 2. Create a balanced metatarsal loading 3. Establish a functional metatarsophalangeal joint, and 4. Create flexor power to a stable digit.

INCISION CONSIDERATIONS

A variety of incision approaches have been presented since Hoffman's original plantar transverse approach that was described in 1911.[2-5] These approaches include a single dorsal transverse, 3 or 5 dorsal linear, and combined dorsal linear and plantar transverse wedge. The choice is made depending on the existing pathology and on the surgeon's preference.

The plantar transverse incision remains a popular approach by many surgeons. It provides excellent exposure to all metatarsal heads, regardless of the degree of digital dislocation. Although lesser digital reconstruction will require additional dorsal incisions, the first metatarsophalangeal joint can be addressed plantarly (Fig. 1). This approach is generally chosen when the degree of digital dislocation is severe, and significant metatarsal head depression exists (Fig. 2). It is also used when a dorsal approach would be contraindicated for any reason.

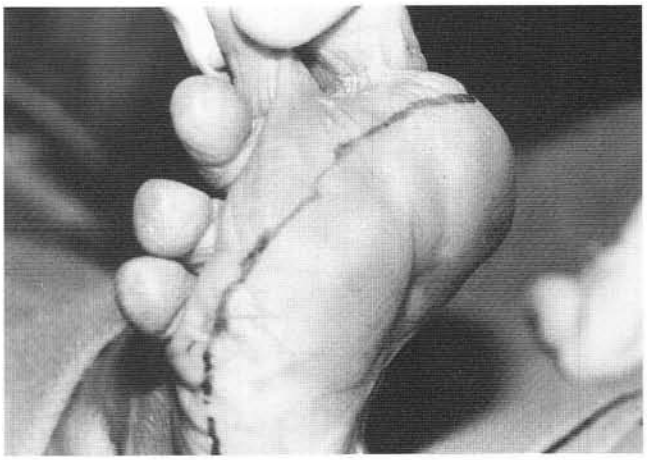

Figure 1. Plantar transverse incision located just proximal to the metatarsal sulcus. Note the proximal extension of the lateral wing.

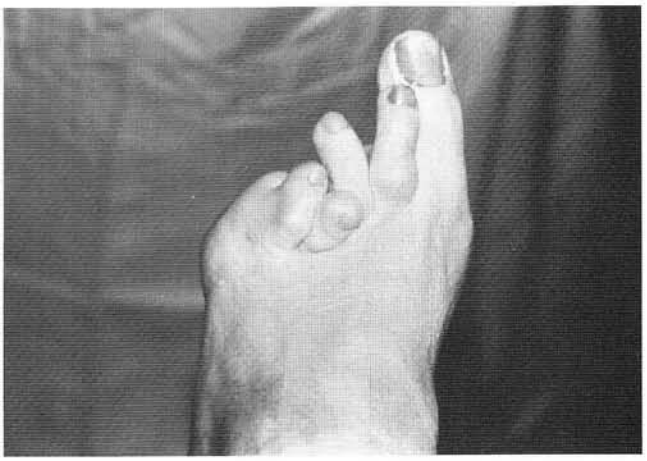

Figure 2. Note the severe digital dislocations making access to the metatarsal heads difficult.

From a technical standpoint, the curvilinear incision is placed just proximal to the metatarsal sulcus, and is extended medially and laterally as far proximal as needed for metatarsal reconstruction. Although early literature alludes to the potential compromise of the digital neurovascular supply following this approach, careful dissection will prevent this in the vast majority of cases.

The dorsal transverse approach described by Clayton is probably the least frequently used incision. Although it gives excellent exposure to the metatarsal parabola, it does not allow exposure of the digits. Concomitant digital reconstruction would require five additional incisions and greatly increase the risk of vascular compromise. However, when digital reconstruction is not required, this incision is a viable option (Fig. 3).

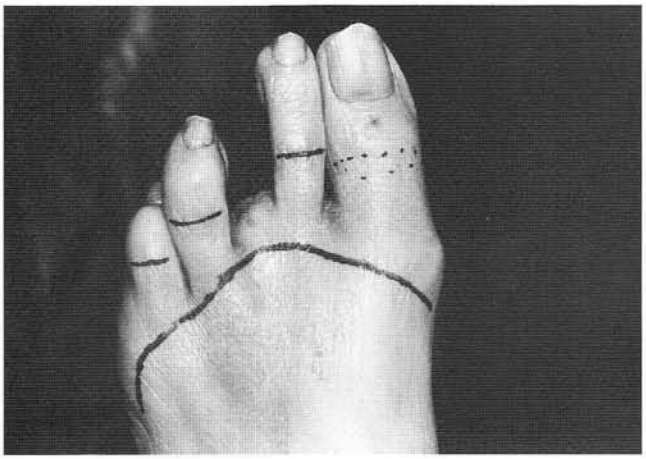

Figure 3. The dorsal transverse incision is used when little digital deformity is present.

The dorsal linear incisions have become the most popular choices for today's surgeons. Although advantages and disadvantages exist for each, the choice of whether to use three or five incisions is based primarily on surgeon preference.

When a three-incision approach is chosen, the most lateral two are placed between the second and third, and between the fourth and fifth metatarsals respectively. The most medial incision is placed along the first metatarsal shaft and can be extended as far proximal as needed for metatarsal reconstruction (Fig 4). Lesser hammertoe repair will again require additional dorsal incisions placed over each digit. Other disadvantages to this approach include an increased amount of side-to-side dissection required to access each of the adjacent metatarsal heads. This not only results in more soft tissue disruption but also increases the potential for vascular compromise. The advantage to this approach is that the central island of tissue between the incisions is much wider than it is with five incisions. This limits the chances of creating an area of dysvascularity between the incisions.

The approach using five dorsally-placed linear incisions offers the best exposure, with the least number of incisions. All areas of reconstruction, both metatarsal and digital, can be easily addressed with this technique (Fig. 5). However, careful pre-operative incision planning is mandatory with this

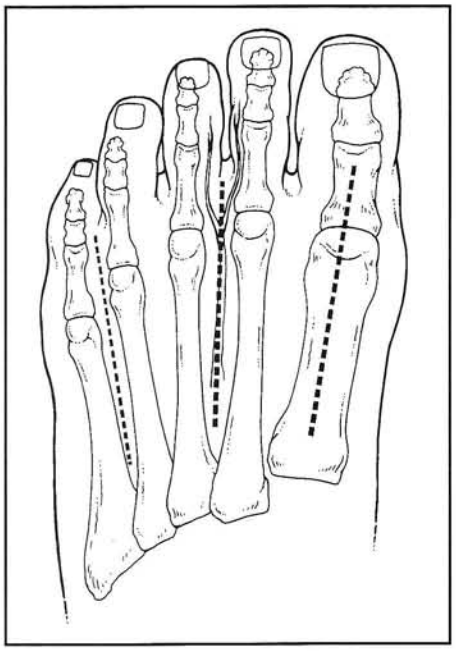

Figure 4. The normal location of a three dorsal-linear incisional approach. Note their location over the neurovascular structures.

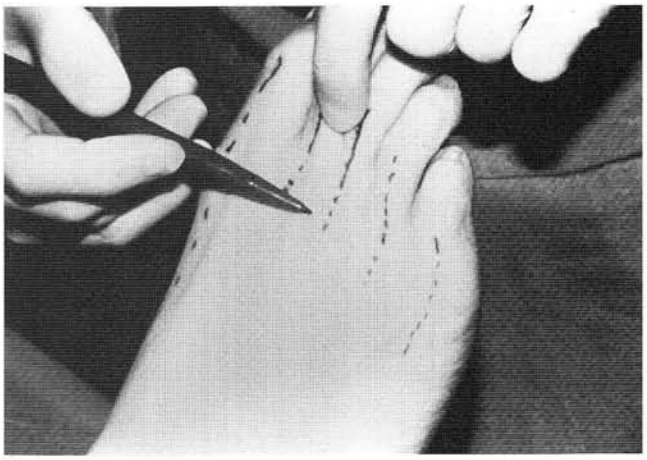

Figure 5. The five dorsal-linear incisional approach with proximal extension noted along the first and fifth rays.

option. The central three incisions are placed over their respective digits and extended proximally over the neck of the metatarsal. Care must be taken to limit this proximal extension so as to not create long, thin islands of tissue that would be subject to necrosis. The incisions over the first and fifth metatarsals are kept as far medially and laterally as possible, and can be safely extended proximally for any required metatarsal work. If more proximal exposure is needed in one of the middle three incisions, it should be done carefully and only to the extent that is needed. Because of the excellent exposure it affords and the relatively few complications associated with it, this method has become the incision of choice for many faculty members of The Podiatry Institute.

In certain clinical scenarios, such as the dislocated rheumatoid foot, a combined dorso-linear and plantar-transverse approach is demanded (Fig. 6). If redundant tissue or rheumatoid nodules need to be removed, the plantar incision is fashioned into a wedge. This is done by placing two semi-elliptical incisions distal to where the newly constructed metatarsal parabola would be. Upon resecting the full-thickness wedge of tissue, tissue redundancy is reduced, the nodules removed, and a significant plantarflexory force is placed on the digits with final closure.

TENDON AND CAPSULAR DISSECTION

As the dissection is carried deeper, careful anatomic separation of layers will allow for more accurate identification of existing pathology and more complete hemostasis. A clean plane of dissection between the superficial and deep fascial layers will provide excellent visualization of the extensor tendon complex and capsular tissues at the level of the metatarsophalangeal joint (Fig. 7).

The decision to include digital stabilization techniques (interphalangeal joint arthrodesis) as part of the overall repair has traditionally been guided by the degree of deformity present in the digits. However, the routine use of digital stabilization procedures should be considered. By arthrodesing the interphalangeal joint, the long flexor tendon complex is converted to a plantarflexor at the metatarsophalangeal joint, and creates a functional range of motion around a purchasing digit. This becomes important when considering the amount of shortening that occurs with many of these procedures. This shortening, combined with the extensive release and lengthening procedures dorsally, can create an unstable and poorly purchasing digit. This can occur regardless of the degree of preoperative deformity in the digits.

The extensor tendon complex is typically lengthened in an open Z-plasty fashion. The proximal arm of the tendon is dissected across the metatarsophalangeal joint making sure to completely release the contracture at the extensor hood apparatus. If no significant contracture exists in the extensor tendon or hood, yet digital arthrodesis is desired, a simple transverse incision through the tendon at the interphalangeal joint is sufficient.

Figure 6. A plantar wedge resection allowing for removal of redundant tissue or nodules. Note the primary reconstruction was done from a dorsal approach.

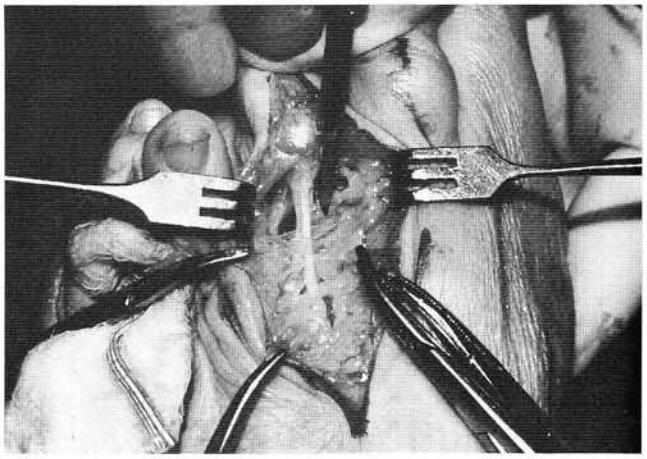

Figure 7. A clean separation of the superficial and deep fascial layers allows easy identification of underlying pathology.

Once the extensor tendon and hood have been released, the metatarsophalangeal joint capsule is opened. A complete dorsal, medial, and lateral release is performed exposing the metatarsal head and proximal phalangeal base. Plantar tissues, including the flexor plate, are freed with a metatarsal elevator or with sharp dissection (Fig. 8). These maneuvers allow for a complete degloving of the metatarsal head.

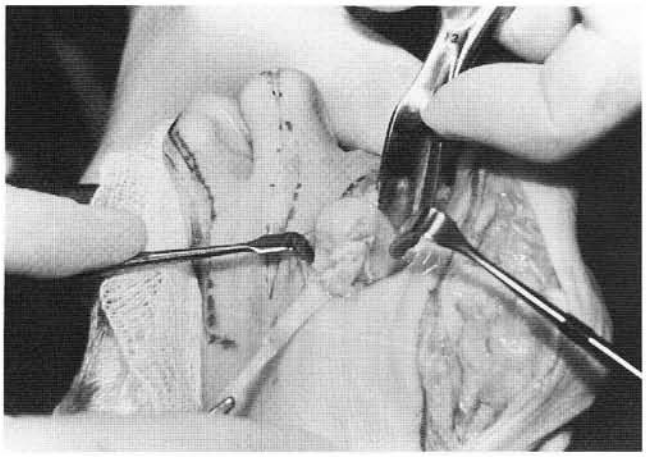

Figure 8. The metatarsal elevator is being used to release plantar adhesions and deglove the first metatarsal head.

At the level of the interphalangeal joint, the tendon is reflected distally and the collateral ligaments transected, displaying the proximal phalangeal head and middle phalangeal base. The actual removal of cartilage and pinning of the joint will be delayed until the metatarsal heads have been resected.

OSSEOUS RESECTION

Two important decisions need to be made when beginning to resect the metatarsal heads: how much bone should be removed; and what is the desired postoperative metatarsal parabola? The success or failure of the procedure is often dictated by the decisions made at this juncture.

The amount of bone resected should be enough to remove all contracture and deformity at the joint, and allow for a restoration of a pain-free range of motion. The potential for vascular embarrassment to the digit is another consideration when determining the amount of bone to be removed. If the initial resection allows for adequate realignment of the digit, but significant tension remains on the neurovascular structures, additional resection will be necessary. In general, a .75 cm to 1 cm gap should exist between the proximal phalangeal base and the newly resected metatarsal stump (Fig. 9).

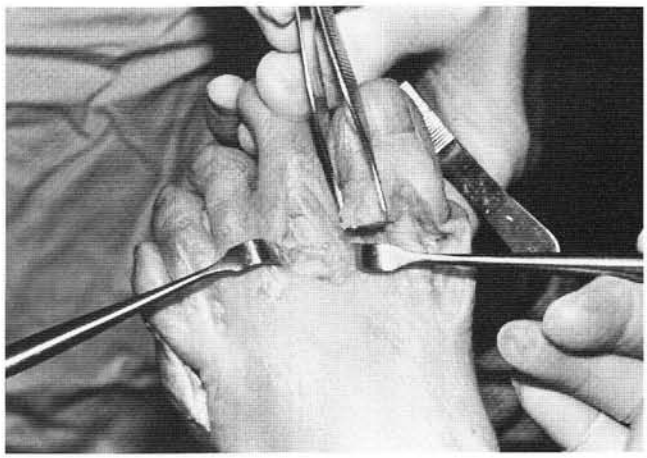

Figure 9. Resection of the metatarsal head should allow for adequate relaxation of all peri-articular soft tissues.

Determining the correct metatarsal parabola is not as clear cut as the previous issue, and therefore some differences of opinion exist. The most commonly reported pattern is 2>1=3>4>5 (Fig. 10). This is based on the normal anatomy of the foot, where the second metatarsal is the longest. The alternate length pattern is 1=2>3>4>5 (Fig. 11). With this length relationship, there is an increased weight-bearing load under the first ray. This may be of significant benefit when attempting to create a more normal gait with final toe-off occurring at the great toe.

Once the desired length has been established, intraoperative radiographs should be taken to confirm the clinical suspicions (Fig. 12). Prior to pinning, clinical palpation of the plantar aspect of the foot should be performed to identify any existing prominence. If a pressure point is found, the respective metatarsal stump should be further remodeled, despite the possibility of a poor radiographic appearance.

The direction of the resection should be from dorsal to plantar without creating a plantar bevel as traditionally proposed (Fig. 13). Any remaining plantar prominence or uneven edges can be smoothed with rasping or burring techniques (Figs. 14A, 14B).

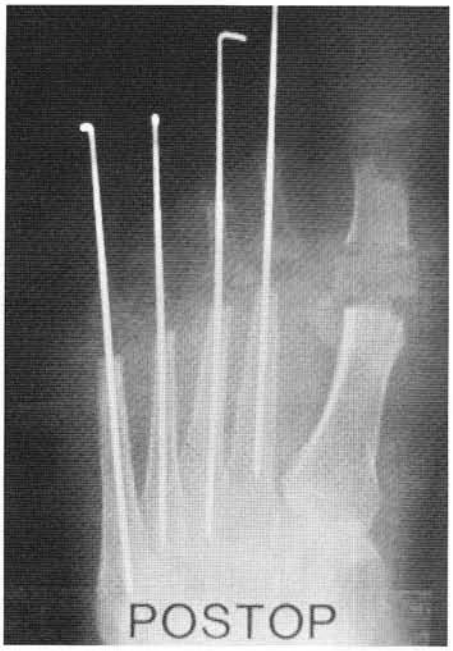

Figure 10. The most commonly proposed length pattern with the second metatarsal being the longest.

Figure 11. Intraoperative radiograph demonstrating equal length between the first and second metatarsals.

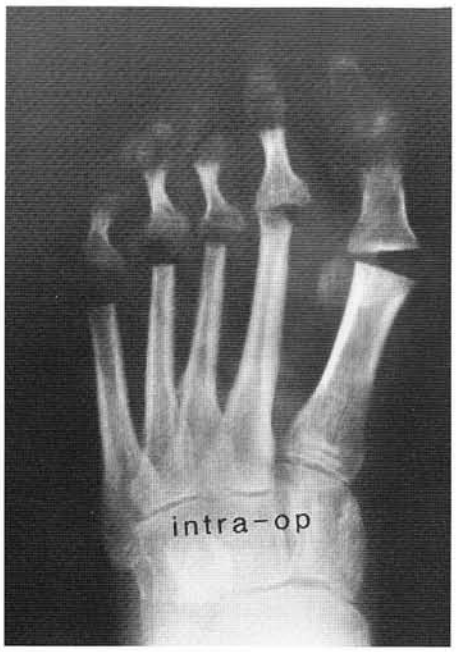

Figure 12. Intraoperative radiograph identifying the 2nd metatarsal as being left excessively long.

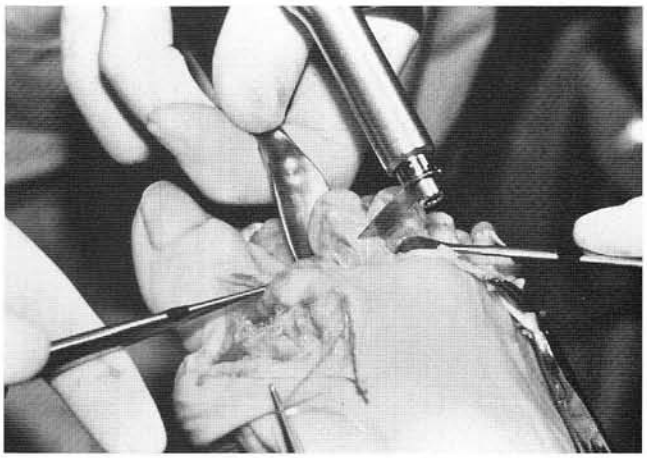

Figure 13. Resection of the metatarsal head at a right angle to the ground.

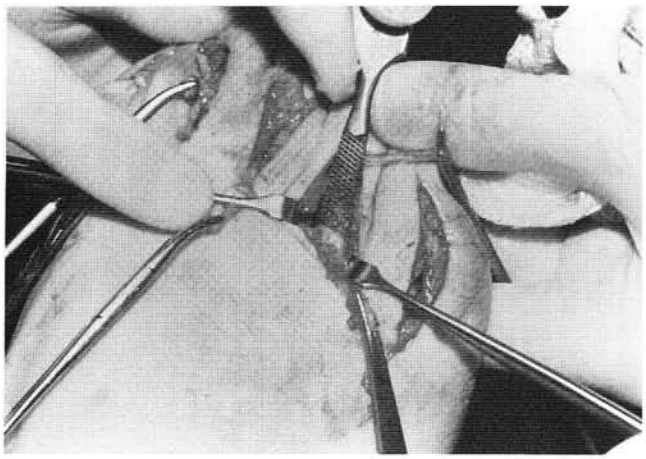

Figure 14A. Remodeling of the plantar aspect of the metatarsal with hand instrumentation.

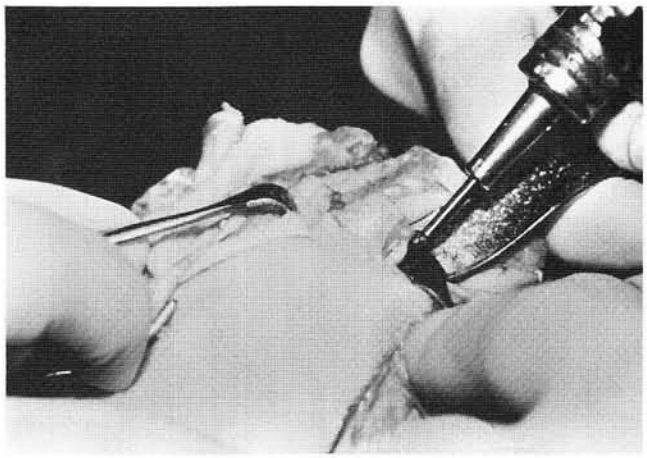

Figure 14B. Remodeling of the metatarsal head with power burr technique.

DIGITAL STABILIZATION

The final stage of the reconstruction includes arthrodesis of the interphalangeal joint and pinning across the metatarsophalangeal joint into the metatarsal shaft. Occasionally, the pin will need to be advanced into the metatarsal base to assure adequate stability (Fig. 15). The digit is typically pinned at a slightly over-corrected plantarflexed position. This position is maintained for approximately 6 weeks, allowing for ample fibrosis to occur at the metatarsophalangeal joint. The choice of end-to-end versus peg-in-hole type arthrodesis is left to the surgeon's preference.

Figure 15. The K-wires are advanced into the metatarsal bases to allow for increased purchase.

FIRST RAY CONSIDERATIONS

Another important decision involves the choice of procedures used in reconstructing the first metatarsophalangeal joint. There are essentially four options: 1. Resection arthroplasty involving both the metatarsal head and proximal phalangeal base (Keller procedure) (Fig. 16A), 2. Resection arthroplasty involving the metatarsal head only (Fig. 16B) 3. Total implant arthroplasty, (Fig. 16C) and 4. First metatarsophalangeal joint arthrodesis (Fig. 16D). Although several factors need to be considered, the choice is often dictated by the underlying etiology and degree of deformity present. For example, in patients with more chronic and progressive disease states such as rheumatoid arthritis and diabetes, arthrodesis may provide the best long-term stability.

If resection arthroplasty is chosen, the most functional option is to leave the proximal phalangeal base and its musculo-ligamentous attachments intact. This minimizes the risk of creating a non-purchasing great toe as is commonly seen in Keller arthroplasty procedures.

With the exception of maintenance of joint space, implant arthroplasty offers little advantage over the other alternatives. A complicated patient population along with its own inherent complications limit the use of implants with metatarsal head resection techniques.

Figure 16A. Keller arthroplasty technique on the proximal phalanx.

Figure 16B. Resection arthroplasty to the metatarsal head only. The intrinsic ligament and muscle attachments to the base of the proximal phalanx are maintained.

Figure 16C. Implant arthroplasty using a two-piece metallic implant.

Figure 16D. Arthrodesis of the first metatarsophalangeal joint.

POSTOPERATIVE MANAGEMENT

The use of drains is determined by the incision approach and the degree of hemostasis obtained. Drains are rarely used when an isolated dorsal approach is used. The exception may be the dorsal-transverse incision which allows easy placement of the drain from medial to lateral. When plantar incisions are used, either isolated or in combination with dorsal ones, a drain for the first postoperative 24 to 48 hours is recommended.

The initial dressing placed at the conclusion of surgery should be bulky and compressive to control hemostasis and edema. Weight bearing is minimal during the first 48 hours, but can be tolerated if a protective surgical shoe is worn (Fig. 17). The pins are kept in their original position for 6 weeks. This not only provides ample time for the arthrodesis to occur, but also allows increased time for fibrosis to occur at the metatarsophalangeal joint.

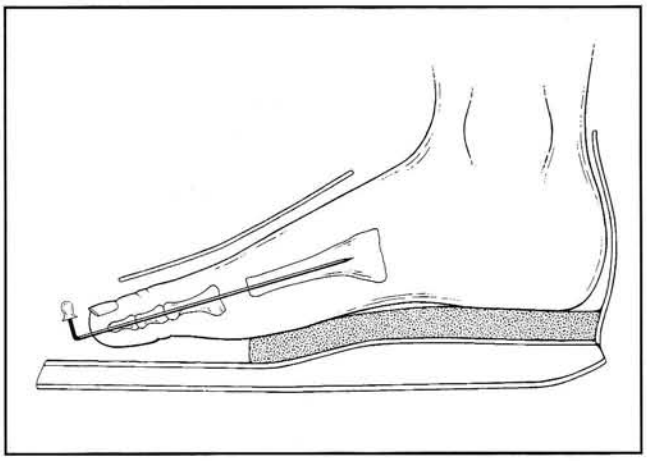

Figure 17. 1/2 inch felt padding extended to the metatarsal sulcus on the surgical shoe to prevent pin bending when the patient is bearing weight.

CONCLUSION

Since its original description in 1911, the panmetatarsal head resection has become instrumental in treating the rheumatoid forefoot. The procedure provides a means of realigning the obvious deformities, reestablishing a pain-free range of motion at the metatarsophalangeal joint, and creating a stable, purchasing digit for final propulsion. As a result of its success in the rheumatoid foot, indications are now expanded to include a variety of forefoot derangements. These include the diabetic Charcot forefoot, chronic metatarsal ulcer disease, post-traumatic arthrosis, and iatrogenic causes of chronic forefoot pain.

From a technical standpoint, the procedure has undergone various modifications over the years. The combined technique of metatarsal balancing and digital stabilization has allowed the procedure to advance from a pure structural correction to one that also restores some degree of function.

REFERENCES

1. Hoffman P: An operation for severe grades of contracted or claw toes. *Am J Orth Surg* 9:441-449, 1911-1912.
2. Clayton ML: Surgery of the forefoot in rheumatoid arthritis. *Arch Rheum* 2:84-85, 1959.
3. Larmon WA: Surgical treatment of deformities of rheumatoid arthritis of the forefoot and toes. *Bull Northwest Univ Med School* 25:39-42, 1951.
4. Hodor L, Dobbs B: Pan metatarsal head resection. *J Am Podiatr Assoc* 73:287, 1983.
5. Fowler AW: A method of forefoot reconstruction. *J Bone Joint Surg* 41B:507, 1959.