CHAPTER **26**

THE SURGICAL MANAGEMENT OF THE RHEUMATOID ARTHRITIC FOREFOOT

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The patient with rheumatoid arthritis presents a particular challenge to the surgeon dedicated to the reconstruction of severe foot deformities. While the indications for surgical reconstruction of forefoot deformities are well known, it must be emphasized that rheumatoid arthritis is a progressive, systemic inflammatory disease of mesenchymal tissue which ultimately affects many organ systems of the body. Its effects on the entire musculoskeletal system can be crippling and disabling, depending on the nature, severity, and rate of progression of the disease process.

A basic understanding of the disease process and its various clinical forms and prognosis are prerequisites for successful surgical reconstruction of the rheumatoid arthritic foot. The success of surgery will depend upon a team approach. Failure to integrate and incorporate internal medicine, physical therapy, and rheumatology in the comprehensive management of the patient may invite complications throughout the perioperative period. It may be necessary to adjust dosages, or discontinue certain medications prior to surgery. Steroid supplementation is not uncommon in patients who have been maintained on low dose Prednisone. Cervical spine radiographs should be obtained if the patient is undergoing general endotracheal anesthesia. Patients who are chronic smokers may require pulmonary function testing to assess respiratory function prior to undergoing a general anesthesia. Only after a comprehensive evaluation has been completed can an accurate assessment of the patient as a surgical candidate, be made.

INDICATIONS AND CONSIDERATIONS

The indications for forefoot reconstructive surgery in a patient with rheumatoid arthritis include gross physical deformity with resultant pain and limitation of normal function. The primary deforming force in the rheumatoid arthritic foot is soft tissue contractures. Multiple joint effusions and intense synovitis result in instability of the metatarsophalangeal joints, with the long-term effects being severe digital contractures and deformities. This may include both dorsal and transverse plane dislocation of the digits. Anterior migration of the plantar fat pad is predictable in such cases and will contribute further to severe metatarsalgia, diffuse plantar tylomas, intractable plantar keratomas, as well as ulcerative and pre-ulcerative lesions. Ultimately, normal function is restricted, with the end result being severe pain and disability to the point that many patients will be able to walk and stand only minimally during the course of a typical day. Even activities of everyday living become a major undertaking for such patients (Fig. 1).

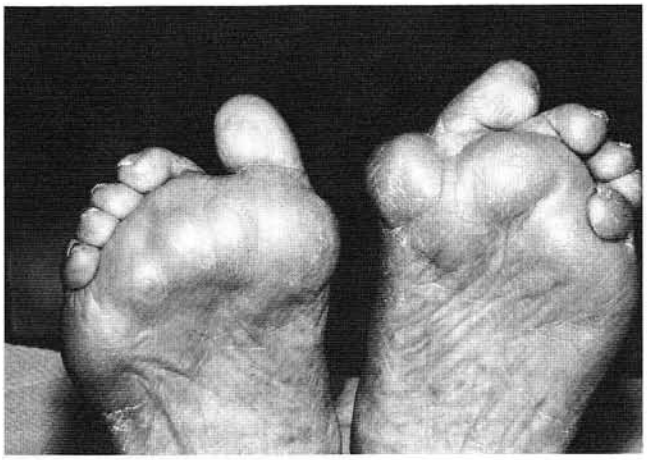


Figure 1. Typical clinical presentation of a patient with severe long-standing rheumatoid arthritis. Note the multiple rheumatoid nodules.

Instability of the first metatarsophalangeal joint typically results in the formation of a severe hallux abducto valgus deformity, with or without degenerative changes to the joint. This is commonly secondary to the inflammatory disease process itself. It soon becomes more difficult to tolerate conventional shoes due to a physical incompatibility. Ambulation then becomes increasingly more painful and limited. Eventually the hallux may become so severely dislocated that it underlaps the second, third, and even the fourth toe. Ulcerations may occur over the medial bunion prominence.

In addition to the severe derangements of the hallux and lesser digits, large unsightly and painful rheumatoid nodules can be present in a number of different areas on the plantar aspect of the foot. These include the hallux and lesser metatarsophalangeal joint areas, the interphalangeal joint area of the great toe, the base of the fifth metatarsal and the infracalcaneal area. To the inexperienced physician, these rheumatoid nodules may be passed off as representing the prominence of the metatarsal heads. However, careful clinical evaluation and inspection will reveal otherwise. These lesions can be confirmed by the use of a soft tissue window CT scan or MRI. The author does not recommend the routine use of such studies to evaluate these lesions, because the benefit from such a costly test is minimal.

The goals and objectives of surgical reconstruction should be to relieve pain, prevent further destruction, improve function, and provide long-term stability to the forefoot. While significant improvement in the cosmetic appearance of the foot is almost always inevitable, it should be thought of as a by-product, and not as the primary objective of the surgery. Furthermore, the surgeon must maintain realistic goals. Treatment should be geared towards providing an optimal functional capacity with minimal pain and maximum duration of the improved state, at the same time maximizing the safety of the surgical procedures undertaken. Perfection, in some cases, may not be a realistic or achievable goal, even in the most highly responsive patients and in the hands of the most skilled surgeon. The surgeon should carefully balance the patient's needs and the severity of the deformity against his or her own surgical skills and ability. Surgical reconstruction of the rheumatoid arthritic foot is not to be taken lightly and should not be undertaken by the novice surgeon. Finally, effective communication between the patient and surgeon is critical to a successful outcome.

A symptomatic approach to surgery in the rheumatoid foot is discouraged. The exception to total reconstruction is the patient with severe deformities but very minimal disability. The author has had patients with severe deformities but in whom the only complaint is one or two prominences which do not reflect the severity of the visual deformities. In these cases, a simple symptomatic approach has been undertaken with great success (Figs. 2A, 2B).

In reconstructing the forefoot deformities of the rheumatoid arthritic patient, the "all or none" law generally applies. In most cases, either the entire forefoot is reconstructed or nothing is done at all. Many times attempts at partial corrective surgery (resection of one metatarsal head or isolated metatarsal osteotomy) results in early recurrence of the deformity alone, or in combination with more severe deformities of the adjacent rays. If one considers the forefoot as a functional unit, the outcome of surgery is likely to be better than treatment of an "isolated broken part" (Fig. 3).

Figure 2A. A 76-year-old patient with severe long-standing rheumatoid foot deformities. Only symptomatology was attributed to the bunion.

Figure 2B. Postoperative x-ray one year later following first metatarsal head resection which gave complete resolution of the symptoms.

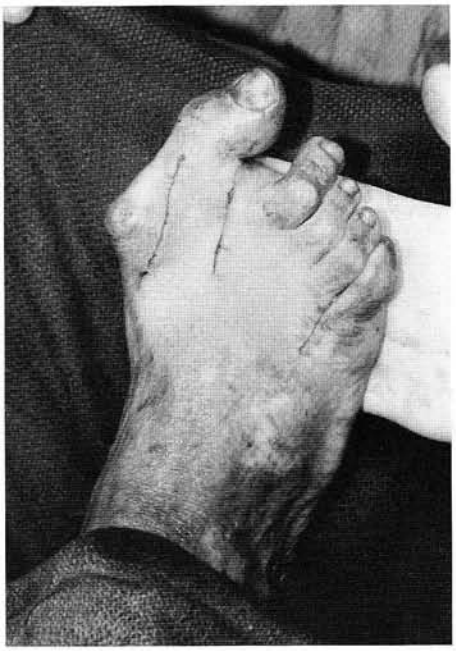


Figure 3. Photograph showing poor application of the principles of rheumatoid foot management. The patient had a panmetatarsal head resection with an implant arthroplasty of the first MPJ.

Surgical timing is also an important consideration. Although there is no ideal time for surgical reconstruction to be undertaken, it is generally agreed that active disease should be absent and the patient should be in a period of quiescence, remission, or "burned out."

THE BUILDING BLOCK: PANMETATARSAL HEAD RESECTION

Numerous approaches have been described for reconstruction of the rheumatoid arthritic forefoot. In 1911, Hoffman provided the original description of the panmetatarsal head resection, which to this day has proven to be the most effective procedure for the treatment of the severe rheumatoid arthritic foot. Hoffman stated "The condition is practically that of multiple hammertoes, affecting several, though more frequently, all the toes of one or both feet..." Hoffman further stated that the purpose of the operation "Is simply to get rid of the metatarsal heads, because they make the patient's life miserable. Every step he takes hurts him, so that he is afraid to get up from his chair."

Although many other approaches and modifications have been described, the panmetatarsal head resection continues to be the mainstay and basic foundation for successful reconstruction of most rheumatoid arthritic forefeet. The procedure includes resection of all of the metatarsals, including the first metatarsal head. Often, the procedure has been described as being a resection of the second through fifth metatarsal heads with a Keller-type procedure on the hallux. Preservation of the first metatarsal head in conjunction with resection of the second through fifth metatarsal heads is likely to be met with failure. Such an approach is fraught with failure and complications, with the most common being a recurrence of the bunion deformity.

An aggressive resection of the metatarsal heads is recommended. Each of the metatarsal heads is transected in the distal diaphyseal portion of the bone. Transection in the more distal metaphyseal area is prone to osseous proliferation, and commonly necessitates a revisional metatarsal head resection in the future.

There has been much discussion about the most appropriate metatarsal parabola. Typically, a parabola favoring the second metatarsal bone as being the longest has been advocated. The author prefers a parabola in which the first and second metatarsals are generally about equal in length, with gradual sloping or tapering of the second, third, fourth, and fifth metatarsal bones. It is not necessary to leave the second metatarsal bone as the maximum protrusion point, because the foot will not function with normal biomechanics.

The angle of transection of the metatarsal has also been a topic of debate. The faculty of the Podiatry Institute prefers to transect each of the bones with a power oscillating saw, perpendicular to the long axis of the bone, or with a very slight bevel from dorsal-distal to plantar-proximal. In either case, the periphery of the distal end of the metatarsal head (especially the plantar aspect) should be contoured with a power bur. A sharp angle from dorsal-distal to plantar-proximal is not necessary, because once a metatarsal head has been resected, the remaining bone bears minimal weight. Transection of a metatarsal bone from dorsal-proximal to plantar-distal, however, should be avoided. This would result in a spike which could potentially cause problems, even with minimal weight bearing.

Power instrumentation is generally recommended for transection of the bone. Although not scientifically or conclusively proven, it stands to reason that the use of power instrumentation will

avoid excessive splintering of the end of the metatarsal bone. These "micro-fractures" encourage osseous proliferation and bone callus formation. When a panmetatarsal head resection is performed from a plantar approach, hand instrumentation, although not preferred, may be necessary for resection of the metatarsal heads. The use of power instrumentation for panmetatarsal head resections from a plantar approach can prove difficult and challenging.

The author discourages the use of any type of implant in the lesser metatarsophalangeal joints. Metatarsal caps and implants have not been found to provide better long-term results than the conventional panmetatarsal head resection. The indiscriminate use of foreign materials in immunocompromised hosts may encourage postoperative complications. Nonetheless, in some cases a double-stemmed implant may provide added stability to the lesser metatarsophalangeal joint. When using these implants, the base of the phalanx is left intact and the implant inserted directly through it. This allows for preservation of intrinsic muscular function and further enhances stability in the transverse and sagittal planes.

The Lesser Digits

Several authors have recommended resection of the proximal phalangeal bases along with metatarsal head resection. Most notably are the articles of Clayton published in the early 1960s in which he suggested that the proximal phalangeal bases are a contributing factor to the recurrence of calluses and pain. In addition, he suggested that the proximal phalangeal bases were enlarged. Clayton did, however, astutely note that resection of the base of the proximal phalanx of the fifth digit would produce a flail toe and therefore advised against it. This approach is strongly discouraged and has no functional basis for its support.

Most surgeons would agree that their own purpose for resection of the proximal phalangeal bases is to gain exposure to each of the adjacent metatarsal heads for resection. In these cases the metatarsophalangeal joint has undergone such severe dislocation that the proximal one-half of the phalanx sits directly over the metatarsal head and neck. Resection of the phalangeal bases further decreases the stability of the digit following panmetatarsal head resection. Any potential stability which would be imparted by the intrinsic musculature is now lost. In addition, raw surfaces of bone are left adjacent to one another, creating an undesirable situation. In such cases, performing panmetatarsal head resection from a plantar approach will preclude the necessity of resecting the phalangeal bases.

Stabilization of the lesser digits is strongly recommended. This generally consists of an end-to-end arthrodesis of the proximal interphalangeal joint with K-wire stabilization across the metatarsophalangeal joint. The K-wire should extend down the shaft of the metatarsal bone and, if necessary, cross the corresponding tarsometatarsal joint. K-wires which are inserted only a portion of the way down the metatarsal shaft (one-third or one-half) generally have inadequate stability and are unlikely to maintain their position for the recommended postoperative 6 to 8 weeks. K-wires driven to the base of the metatarsal or across the tarsometatarsal joints provide excellent stability for a prolonged period of time. After the K-wire has been properly seated, distraction is confirmed at the metatarsophalangeal joint level. This space can be expected to fill with fibrous tissue during the postoperative period. Smooth K-wires are effective, and it is not necessary to use threaded K-wires to maintain distraction.

In some cases, the author simply manipulates the digits into a rectus alignment (a "crunch" procedure), and then performs K-wire stabilization without direct surgical fusion of the interphalangeal joints. Based on a limited number of cases, the long-term results do not seem to be significantly different. The digits are clinically rigid, and the rigid-beam effect is maintained, similar to digital fusions. In cases of significant sagittal or transverse plane deformity at the proximal or distal interphalangeal joint level, bone resection will be necessary to accomplish realignment and fusion.

Implants of the lesser digits are not recommended. Although they may add stability to the interphalangeal joint, arthrodesis is the preferred method. In addition, the use of implants in the interphalangeal joints precludes the use of K-wire stabilization.

The Hallux and First Ray

When performing a panmetatarsal head resection, the author generally recommends K-wire stabilization of the great toe similar to that of the

lesser toes. The standard retrograde technique is employed. A 0.054" or 0.062" K-wire is driven through the base of the proximal phalanx, across the interphalangeal joint, and out the tip of the great toe. The hallux is then retrograded down the medullary canal of the first metatarsal to its base. If the wire is unstable, it is driven into the first cuneiform.

In those cases where the surgeon is performing a fusion of the interphalangeal joint of the great toe, an additional K-wire is recommended. The additional wire may be driven parallel to the first K-wire or may be inserted percutaneously, obliquely crossing the interphalangeal fusion site. This will help provide additional stability to the site and prevent frontal plane rotation, as well as separation of the adjacent bone surfaces during the healing period. In some cases, a deformity may still persist, even following resection of the first metatarsal head. Rather than perform a more aggressive resection of the first metatarsal head and create an undesirable metatarsal parabola, the proximal phalangeal base is resected. In other cases, removal or excision of the fibular sesamoid may further facilitate the reduction of the deformity. It must be remembered that when excising the fibular sesamoid or resecting the proximal phalangeal base in conjunction with a first metatarsal head resection, a very unstable hallux may be created. Consideration should be given to simultaneous stabilization of the interphalangeal joint with possible tenodesis of the flexor hallucis longus tendon to the stump of the phalanx.

The author also wishes to emphasize that complete correction of the deformity is not mandatory or necessary in all cases. This is particularly true in the very elderly patient with long-standing severe forefoot deformities. In such cases, a 60% to 80% reduction of the deformity provides equally gratifying results, in spite of the fact that full correction of the deformity has not been achieved.

In some cases, it may be desirable to achieve additional stability of the first metatarsophalangeal joint by either primary arthrodesis or total implant arthroplasty. There are advantages and disadvantages to each procedure. Total implant arthroplasty is used only in those patients where additional stability is desirable, with preservation of range of motion to the joint, and in whom there is no significant deformity of the first metatarsal which would necessitate an osteotomy or a fusion more proximally (metatarsus primus varus). It should be emphasized that the use of a total implant to correct transverse plane deformities (hallux varus or hallux valgus) is inappropriate. Significant mechanical stress and strain can be expected to cause failure of the implant.

In recent years, there have been a number of new great toe implants introduced to the podiatric surgeon. These implants have all been two-component by design and thus are not appropriate for stabilization of the first ray. A two-component implant is very unstable, especially in a patient with rheumatoid arthritis. The most appropriate implant would be the original Swanson design, double-stem, one-piece silicone implant device. This device provides an appropriate surface for articulation with the sesamoid apparatus which will lie directly beneath the central portion of the implant. Although there are other double-stemmed one-piece implants available, these are likely to create problems with articulation of the sesamoid apparatus because of their design. These implants will not glide freely over the sesamoid apparatus, and consequently may result in excessive wear patterns or abnormal clicking sensations with manipulation of the great toe. A total implant arthroplasty can be expected to provide additional stability to the joint with preservation of range of motion. The additional stability will help to prevent medial or lateral drifting of the great toe and, to a lesser degree, sagittal plane drifting (Figs. 4A-4E).

Additional stability of the first metatarsophalangeal joint can be achieved by arthrodesis. This procedure has been found to produce long-term favorable results in many cases. It is most applicable to patients who have an apropulsive gait pattern and in whom their primary activities are simply those of daily living. It may also be used in more active patients, but there is an increased potential for disturbance of the union process with added stress and strains (Figs. 5A-5C).

The technique begins with a first metatarsal head resection to establish the desired metatarsal parabola. A very small section of the proximal phalangeal base is then resected. The phalangeal base and metatarsal head are then recontoured using hand and power instrumentation to create a convex surface on the metatarsal head and a concave surface on the phalangeal base. This will

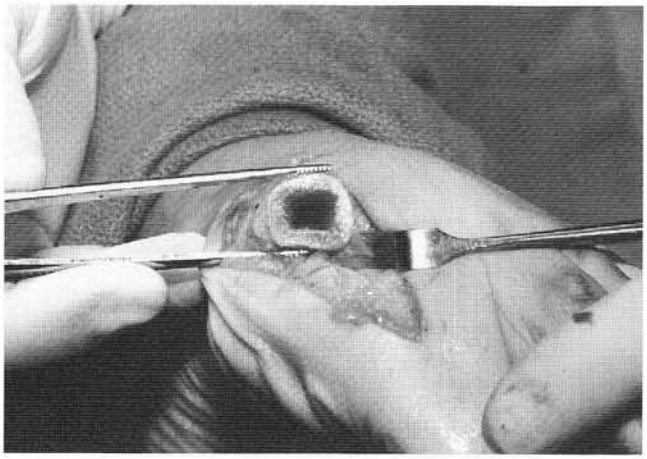


Figure 4A. Appearance of the first metatarsal following preparation for implant arthroplasty.

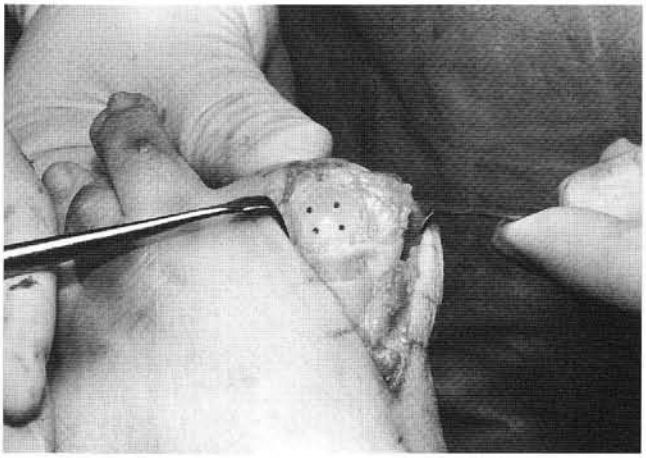


Figure 4B. Proximal phalangeal base with four drill holes to be connected with osteotome. Note entire base has been maintained.

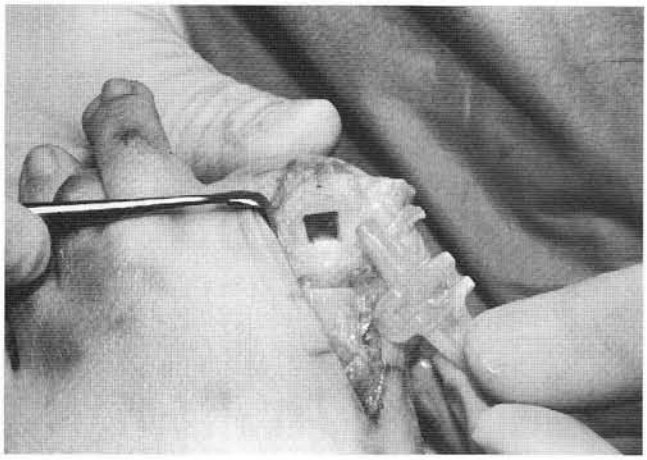


Figure 4C. Appearance of the medullary canal with preservation of the base of the phalanx in preparation for implant arthroplasty. No resection of bone or cartilage has been done.

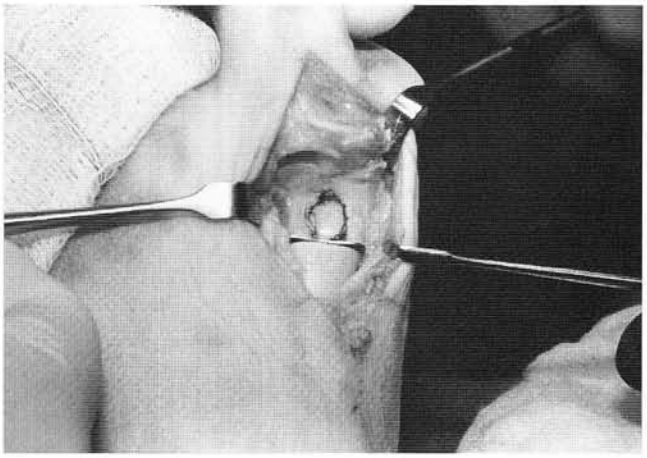


Figure 4D. Demonstrates seating of the grommet on the metatarsal side. The tibial sesamoid is readily visualized. This will articulate with the undersurface of the implant device.

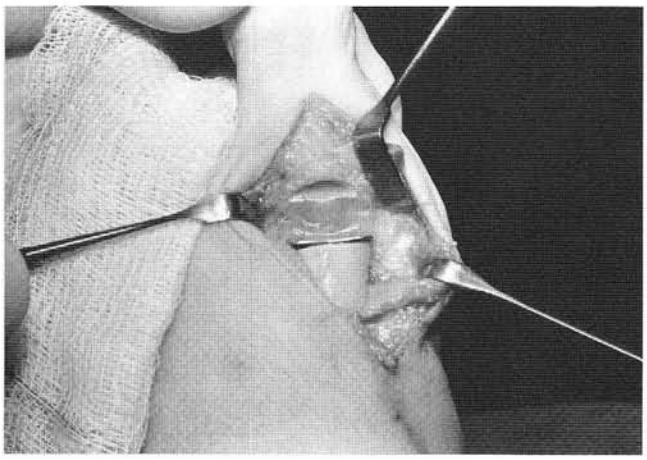


Figure 4E. Final appearance following insertion of the implant. Note the grommet is on the metatarsal side. No grommet is used distally due to the "biological grommet" consisting of the phalangeal base and its subchondral bone plate.

Figure 5A. Postoperative AP radiograph following panmetatarsal head resection, digital arthrodesis and first MTP joint arthrodesis.

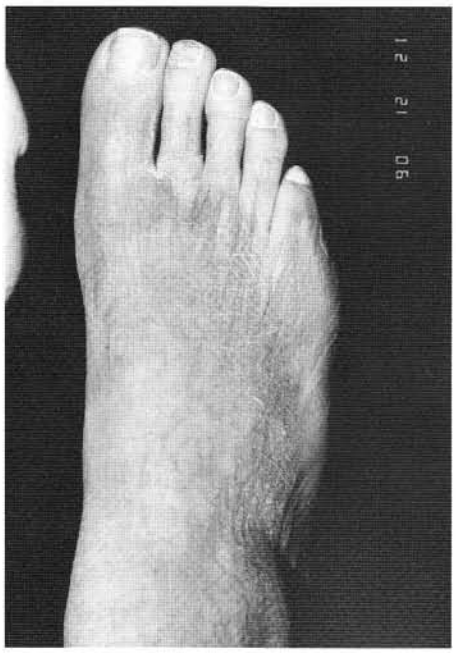


Figure 5C. Clinical appearance of a foot following procedures identified in 5A and 5B.

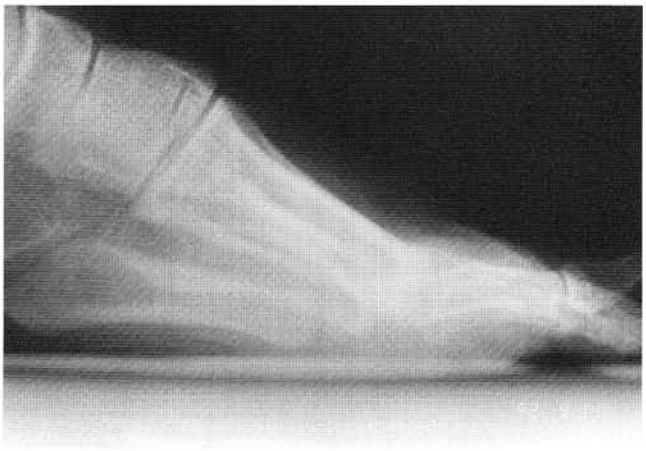


Figure 5B. Lateral postoperative radiograph .

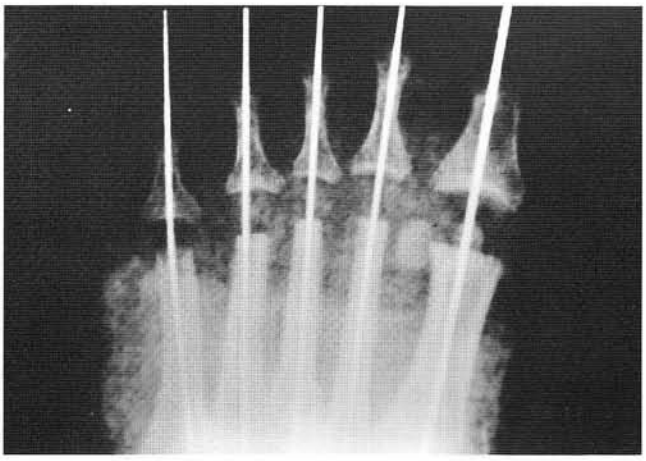
create the most effective reciprocal fit between the two bones and promote arthrodesis.

Because osteoporosis is typical in such patients, the method of fixation should be adjusted accordingly. The author favors less rigid forms of fixation, such as multiple crossing K-wires or Steinmann pins instead of traditional screws or plates, because of the osteoporosis. These techniques have proved quite effective. The surgeon should be aware that a somewhat greater than normal delayed union or nonunion rate has been reported when performing fusion of the great toe in the rheumatoid arthritic patient. Thus, careful postoperative monitoring is necessary to ensure consolidation.

Finally, when performing either arthrodesis or total implant arthroplasty, consideration should be given for a more proximally oriented osteotomy or fusion to correct for a rigid splaying between the first and second metatarsal bones. In general, following adequate resection of bone from the metatarsal head, enough reduction of the intermetatarsal angle will be realized precluding the necessity of an additional procedure. The procedure becomes more critical in situations where one will be performing an implant arthroplasty. If implant arthroplasty is employed in situations where a metatarsus primus varus is left uncorrected, then mechanical stresses and strains can be expected to cause failure of the implant at an early stage.

Intraoperative Radiographs

Intraoperative radiographs are used to confirm establishment of an appropriate metatarsal parabola, and proper placement of the K-wires or other internal fixation devices or implants. An unacceptable metatarsal parabola is further adjusted by appropriate resection of bone. Improperly located K-wires are removed and replaced and additional radiographs taken to confirm proper placement, position, and overall alignment. The author strongly encourages less-experienced surgeons to routinely employ intraoperative radiographs to minimize undesirable results and potential postoperative complications (Figs. 6A, 6B).



Figures 6A and 6B. Intraoperative x-rays showing improper metatarsal parabola. Pins were backed out and additional bone resected from the second, third, and fourth metatarsals to establish the appropriate metatarsal parabola. K-wires were then reinserted.

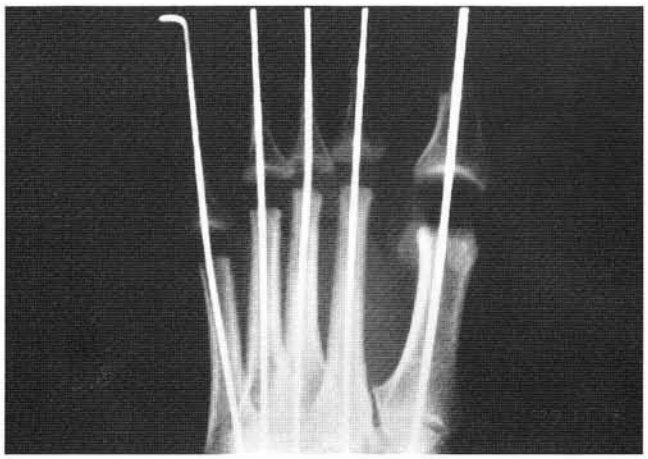


Figure 6B.

SKIN INCISION APPROACHES

A discussion of surgical procedures for reconstruction of the rheumatoid forefoot would be incomplete without addressing the most appropriate skin incision approaches. A variety of different approaches have been recommended over the years. Each has its inherent advantages and disadvantages, and associated complications.

The proposed skin incisional approach should be based upon the type and severity of the digital and metatarsophalangeal deformities as well as the prevalence of plantar rheumatoid nodules which may require excision. The author believes that no "standard approach" should be routinely employed. The surgeon should consider the nature and severity of the deformity, weigh the potential advantages and disadvantages of each particular incisional approach, and then select an approach which will permit correction of the deformity with minimal risks of complications. Personal experience and training alone should not be the deciding factors for the incisional approach when performing panmetatarsal head resection in the rheumatoid arthritic foot.

Plantar Transverse Approaches

Hoffman described a single transverse curvilinear incision on the plantar aspect of the foot just behind the web space area of the toes. This skin incision approach resulted in a large flap of skin and subcutaneous tissues which had to be turned downward in order to gain adequate exposure. In 1959, Fowler described a wedge resection of skin from the plantar aspect of the foot with the convexity of the lips facing toward the heel area. Kates et al. also described a similar skin incision approach.

In general, plantar transverse approaches are extremely valuable in many cases, especially where there is dorsal subluxation or luxation of the metatarsophalangeal joint(s), with gross prominence of the metatarsal heads plantarly. In such cases the base of the proximal phalanx is found dorsal to the metatarsal head, making the dorsal approach extremely difficult. In contrast, the metatarsal head is plantarly prominent directly beneath the skin. Each metatarsal head is easily palpated plantarly. The fat pad is typically atrophied and displaced distally. The plantar

approach is also extremely valuable in patients with plantar rheumatoid nodules in this area (Figs. 7A-7C).

Currently, the author recommends two semi-elliptical incisions with resection of a wedge of skin. The wedge of skin removed directly overlies the metatarsal heads. The medial and lateral extents of the incisions will be the medial and lateral aspects of the first and fifth metatarsal heads. The actual configuration of the skin incision is moon-shaped. The convexity of the incision is distal and the concavity more proximal. This incision takes on the configuration of a frown in contrast to other plantar approaches which have typically taken on the configuration of a smile.

The skin is carefully excised with a small amount of subcutaneous fat attached on the underside. Each of the metatarsal heads is then palpated. A longitudinal incision is made either medially or laterally, depending on location of the long flexor tendon. In some cases it will be difficult to identify the flexor tendon which may be displaced medialward or lateralward, depending on the amount of transverse plane and sagittal plane deviation of the adjacent toe. Once the capsular tissues have been incised longitudinally, the collateral ligaments are released. A McGlamry metatarsal elevator is used to strip the periosteum and capsular tissues from the metatarsal head to the level of the diaphysis. Once each of the lesser metatarsal heads has been exposed, the head is aggressively resected with a power saw. The angle of transection is typically 90 degrees to the long axis of the bone. The resultant plantar stump should be smoothed with a power bur, especially on its plantar side (Figs. 8A-8C).

Once all of the osseous work has been completed and fixation achieved, the incision is prepared for closure. A tourniquet, which is usually employed for hemostasis, is released prior to closure. The incision on the plantar aspect of the foot is packed with gauze sponges or Surgicel impregnated with topical thrombin. A sterile ace wrap is applied and the vasculature allowed to reach equilibrium following release of the tourniquet.

Minimal deep closure is required. One or two over-and-over, or simple interrupted stitches are all that is required to close the deep fascia plantarly. The subcutaneous tissues, however, are meticulously closed with a continuous running

Figure 7A. Clinical view of a patient following rheumatoid foot reconstruction on the right side. The patient is preoperative on the left side. Note the multiple rheumatoid nodules.

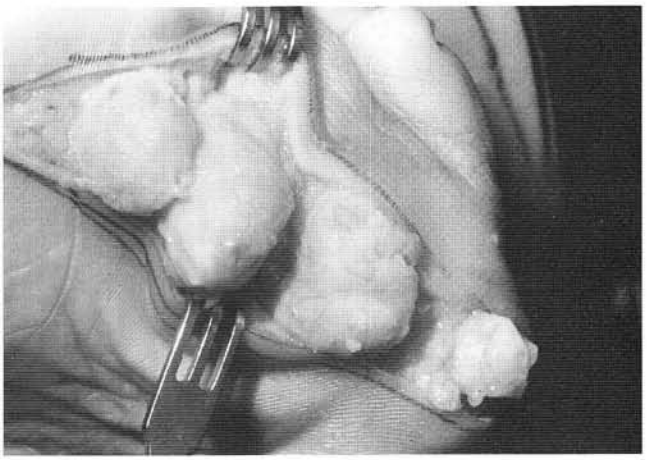


Figure 7B. Intraoperative appearance of the rheumatoid nodules on the plantar aspect of the foot.

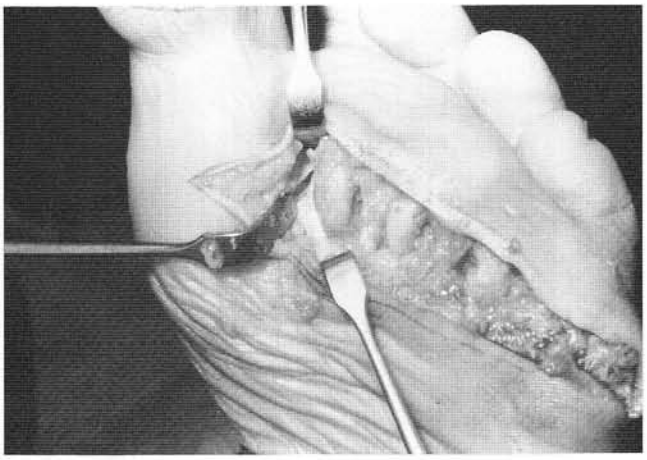


Figure 7C. Metatarsal head is identified following excision of rheumatoid nodules.

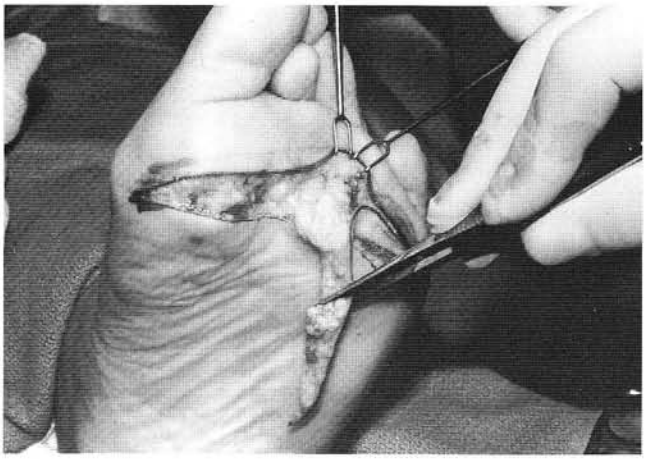


Figure 8A. Intraoperative view showing moon-shaped ellipse of skin, plantar approach for panmetatarsal head resection. Notice the wedge of skin is directly overlying the metatarsal heads.

Figure 8B. Appearance of the second, third, fourth, and fifth metatarsal heads following longitudinal incisions and retraction of the tendons.

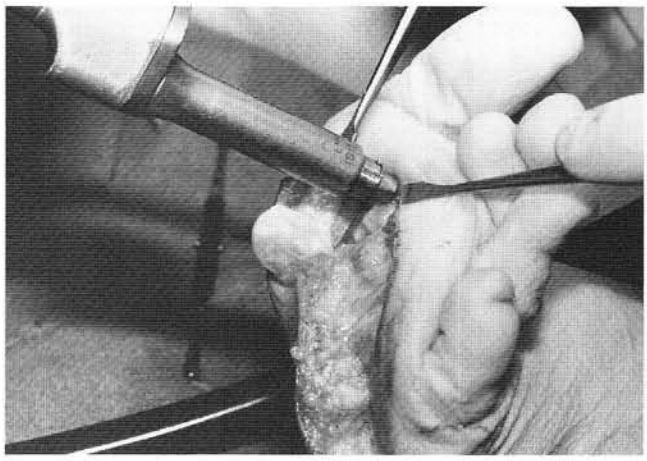


Figure 8C. Resection of the metatarsal head at the diaphyseal-metaphyseal junction with a power oscillating saw. Notice the angle of transection is at 90 degrees to the long axis of the bone.

stitch of 4-0 synthetic multifilament absorbable suture of choice. The skin is then sutured utilizing a series of simple interrupted stitches of 3-0 and/or 4-0 nylon or polypropylene. In order to avoid the formation of dog ears at either end of the incision, the author recommends that the suturing process be done methodically. The incision is bisected and the first stitch placed. The second and third stitches will then further bisect each of the resultant portions of the incision in half. The process continues until sufficient stitches have been placed. In some cases, several large vertical mattress stitches of 2-0 or 3-0 synthetic monofilament suture may be helpful to help reduce tension along the primary incision line (Fig. 9).

When using a plantar incisional approach, it is not uncommon to encounter one or more rheumatoid nodules. These nodules are relatively discrete and firm and attached to the underlying dermis. In some cases, the deep side of the nodule will be attached to the flexor tendons or periarticular structures. They are usually excised along with the resultant skin wedge. A combination of blunt and sharp dissection technique will allow ready extirpation of these lesions. In cases where there have been large painful plantar prominences attributable to rheumatoid nodules, the immediate

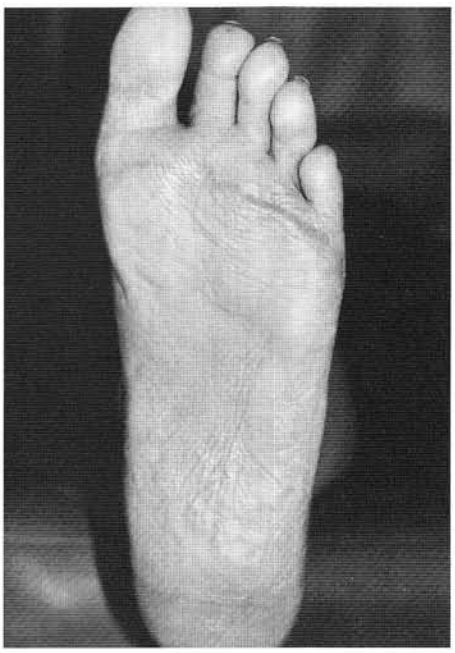


Figure 9. Clinical view several months following excision of multiple rheumatoid nodules from the interphalangeal joint of the hallux, metatarsal heads and heel area. A panmetatarsal head resection and stabilization arthrodesis of the lesser digits with K-wire fixation was also performed.

improvement seen intraoperatively following their excision is most impressive. This is extremely dramatic in those situations where there is minimal sagittal plane deformity of the lesser toes. In some of these cases, it may not be necessary to perform resection of the metatarsal heads. Simple excision of the rheumatoid nodules from a plantar approach may prove to be all that is needed.

There are several advantages of performing a panmetatarsal head resection alone or in combination with excision of rheumatoid nodules from a plantar approach. The resection of a wedge of skin will assist in relocating the plantar fat pad providing additional stability to the lesser digits in a plantar direction. This will decrease the chance of recurrent dorsal subluxation of the digits post-operatively. In addition, panmetatarsal head resections performed from a plantar approach are associated with less wound complications in the postoperative period. Postoperative edema is minimal compared to that seen with three or five dorsal longitudinal incisions. The procedure is technically easier to perform from a plantar approach when the metatarsophalangeal joints are already dislocated.

A disadvantage is that exposure to the lesser digits requires ancillary incisions on each of the lesser toes dorsally. In addition, K-wire stabilization of the digits is more challenging when resecting the metatarsal heads from a plantar approach. A standard retrograde technique is utilized to stabilize the digit itself to the base of the proximal phalanx. The K-wire is then driven through the base, visualized plantarly, inserted directly into each of the metatarsal stumps, and finally driven down the shafts to the base of the corresponding tarsal bones.

Surgeons, in general, have a fear of performing plantar incisions, especially if they have had no prior experience or training. While this fear is appreciated, it is not warranted. These incisions follow the principles of relaxed skin tension lines and are less prone to the formation of a hypertrophic scar, keloid or other wound complication. Performing them directly over the corresponding metatarsal head ensures that they will be in a non-weight bearing area postoperatively.

Surgeons are also concerned about accidental transection of the neurovascular structures. It should be pointed out that in cases where there is significant dorsal dislocation of the digits, the neurovascular structures are also likely to have undergone significant dorsal displacement between the metatarsal heads. Thus, they are unlikely to be encountered during resection of the metatarsal heads from a plantar approach. Accidental injury or transection of the neurovascular bundle is more likely to occur from a dorsal approach.

Dorsal Longitudinal Approaches

A variety of dorsal incisional approaches have been described. In 1958, Clayton described a single transverse dorsal incision just proximal to the bases of the digits. Fowler utilized a similar dorsal approach to resect the metatarsal heads. This approach has been abandoned because it has the greatest likelihood of compromising the dorsal neurovascular structures.

In 1951, Larmon documented the use of three linear incisions for resection of the metatarsal heads. One incision was utilized to expose the first metatarsophalangeal joint. Two other incisions were placed on the foot: one between the second and third metatarsal heads, and a third incision between the fourth and fifth metatarsal heads. This approach has been advocated by other surgeons as well.

In 1983, Hodor and Dobbs described the use of a five dorsal longitudinal incisional approach for the performance of a panmetatarsal head resection. Each of the metatarsophalangeal joints was exposed through a separate incision. This incisional approach also allows exposure to the interphalangeal joints of the lesser toes. Both the three and five dorsal linear incisional approaches have been met with varying responses by the podiatric surgical community. Each has some inherent advantages and disadvantages, and deserve careful consideration.

The three incisional approach, although seemingly less traumatic, may in fact, require increased dissection in order to gain exposure to the adjacent metatarsal heads. It typically involves more manipulation of the neurovascular bundles which will be found traversing longitudinally between adjacent metatarsal heads, and is generally not preferred by the author. Furthermore, it requires additional incisions on each of the toes if arthroplasty or arthrodesis of the digits is to be performed. At the very least, the incision between the second and third metatarsal heads will be carried obliquely onto the second digit

necessitating additional incisions for exposure of the third toe. Likewise, the incision between the fourth and fifth metatarsal heads may be carried obliquely onto the fourth or fifth toe, but then will require an additional ancillary incision on the adjacent toe. This, in effect, results in at least four incisions for successful relocation and stabilization of the lesser digits and resection of the lesser metatarsal heads. A small island of tissue is created between the short incision on the adjacent digit and the primary incision between the metatarsal head which curves gently onto the other toe. This island is prone to wound complications.

When significant dorsal malalignment of the digits is not present, the Podiatry Institute faculty recommend a five incision dorsal approach. The incision over the first and fifth rays will typically be longer than the incisions over the second, third, and fourth rays. In addition, these incisions should be placed medially and laterally over the foot to increase the distance between adjacent incisions. This incisional approach can be successfully used in patients with significant transverse plane deformity. It will provide exposure to each of the metatarsophalangeal joints, with easy access for resection of the metatarsal head. In addition, it provides excellent exposure to the interphalangeal joint for fusion or stabilization of the digits.

It is recommended that each incision be marked out with a skin scribe prior to surgery because of the close proximity of each of the adjacent incisions. This will avoid creating excessively narrow islands of tissue which may be prone to wound complications.

The five dorsal linear incision approach offers some distinct advantages over the three incisional approach. Because of the anatomic placement of each of the incisions, the neurovascular bundles need not be traversed or encountered to any great extent. This leads to less risk of vascular embarrassment or complications provided that the proper technique is followed. These incisions provide excellent exposure to the entire extensor hood apparatus which facilitates the execution of a complete sequential reduction, allowing exposure to the metatarsal head and neck area (Fig. 10). K-wire stabilization of the digits across the metatarsophalangeal joints is readily performed because of the excellent exposure to each ray segment. Because direct exposure is achieved, there is minimal undermining between adjacent incisions. This decreases the risk of a hematoma or other wound complication.

Regardless of the incisional approach employed, meticulous surgical technique is critical. The skin and subcutaneous tissue should be handled very gently. When working on the plantar aspect of the foot, sutures are frequently used to retract the skin edges. Skin hooks provide an effective way for retraction of the dorsal tissues with minimal trauma to the skin. Deeper retraction is accomplished with the use of small Ragnell or Senn retractors. Self-retaining or manual retractors containing sharp edges should be avoided as these impart significant trauma to the tissues. Meticulous and gentle handling of the tissues is also critical during closure. Excessive clamping of the deeper tissues and skin edges imparts significant surgical trauma contributing to an increased incidence of wound complications (Figs. 11A-11F).

Hemostasis

Most Podiatry Institute faculty members use a mid-thigh pneumatic tourniquet when performing surgical reconstruction of the rheumatoid arthritic forefoot, although some prefer the use of an ankle tourniquet. Regardless of the technique utilized, it is not a substitute for gentle handling and meticulous hemostasis during the course of surgery. Vessels should be clamped and ligated or bovied. Some faculty use small amounts of Epinephrine in a dilute concentration of 1:200,000 to 1:400,000 along with local anesthetic infiltration. The surgeon should be careful about an overly generous injection of local anesthetic, as the fluid distention itself can compromise wound healing.

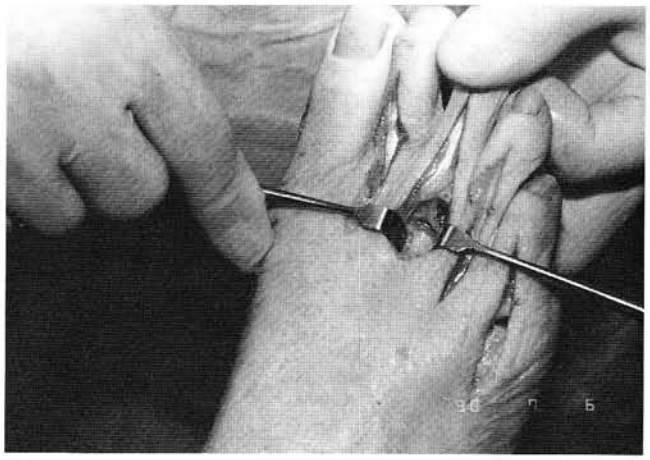


Figure 10. Five incision approach for panmetatarsal head resection. Notice excellent exposure to the joints of the digits, as well as the metatarsal head which has been resected.

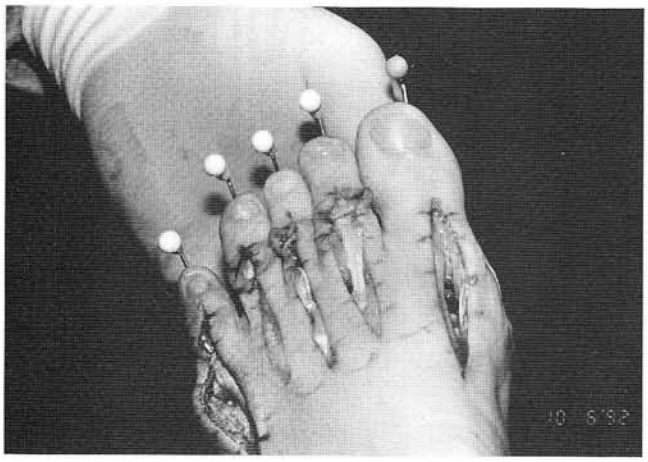


Figure 11A. Five incision approach for panmetatarsal head resection, digital arthrodesis with K-wire stabilization of hallux and lesser toes.

Figure 11B. Clinical appearance of the foot four days postoperatively at the first dressing change. Notice the absence of any wound complication. Mild edema and ecchymosis are noted consistent with the extensive surgery performed.

Figure 11C. Postoperative x-ray following panmetatarsal head resection and digital stabilization. Note location of K-wires down the shafts of each of the corresponding metatarsal bones and into the tarsal bones.

Figure 11D. Same patient, x-rays one year and two months following procedures.

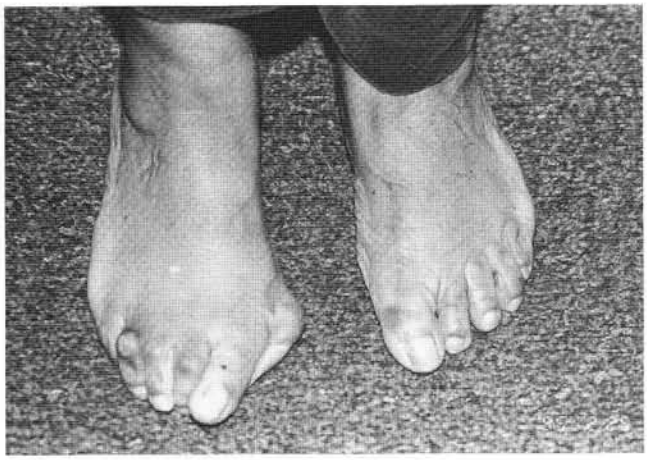


Figure 11E. Clinical appearance of the same patient one year and two months postoperative.

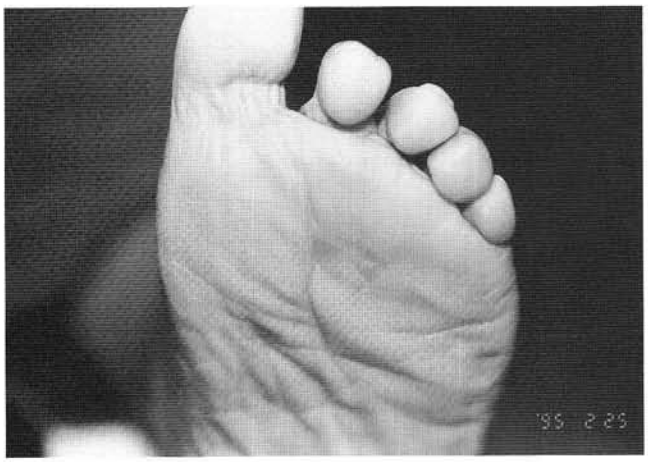


Figure 11F. Clinical appearance, one year and two months post-operative.

In most cases the tourniquet is released prior to wound closure. Chemical agents such as topical thrombin and Surgicel® may be used to facilitate hemostasis during this period. A sterile four inch ace bandage is applied to provide a tamponading effect. A ten minute waiting period, will allow the vascular structures to reach equilibrium.

If there is persistent bleeding, a surgical drain is recommended. A TLS drain system or a Penrose drain are not uncommonly employed. These drains are maintained for 48-72 hours.

POSTOPERATIVE CARE

A dry sterile compression dressing is applied for the first three to five days. This generally consists of a series of Kerlix rolls and two inch or three inch Kling. In addition to this, a Jones compression splint is applied. There is universal agreement among the faculty of The Podiatry Institute that this technique is perhaps the most efficacious way of controlling postoperative edema. Ice and elevation are also important. An alternative is the use of any number of conventional cold therapy systems available today.

Pharmacological agents will also assist in controlling postoperative inflammation and swelling. Certain nonsteroidal anti-inflammatory agents are helpful (Toradol®). In addition, a short burst of systemic steroids can also prove quite effective in controlling the initial phases of pain, inflammation and swelling.

The first major redressing is performed five to seven days postoperatively. A dry sterile dressing is performed. Depending on the type of incisional approach employed, patients are either permitted to ambulate in a modified surgical shoe or maintained non-weight bearing in a surgical shoe or short-leg cast. Patients who have had a plantar incisional approach should be maintained non-weight bearing for approximately three weeks. It is also preferable to keep patients in whom Kirschner wires have been used to stabilize the hallux and/or lesser toes in a non-weight bearing attitude as well. If non-weight bearing cannot be maintained, then appropriate modification should be made to the surgical shoe or cast. This typically consists of the addition of a one-half inch thick felt pad from the heel to just behind the metatarsal head segments. This will help resist bending forces across the metatarsophalangeal joints which could result in a failure and breakage of the K-wires.

Sutures are generally removed at approximately three weeks postoperatively. K-wire fixation is maintained postoperatively approximately 6 to 8 weeks. The author prefers to leave the K-wires as long as possible, and to encourage fibrosis in the area of each of the metatarsal heads resected. Once the K-wires have been removed, compression stockings are employed to help control edema. Digital splinting devices are routinely employed for up to six months postoperatively. These consist of the use of a Darco night splint for the hallux and lesser toes, and the use of digital retaining devices for the lesser toes while wearing shoes (Fig. 12).

Figure 12. Postoperative Darco splint utilized to maintain hallux and digital alignment following panmetatarsal head resection. A compression stocking has also been applied to help control edema.

COMPLICATIONS

Inherent with any type of major surgery, such as reconstruction of the rheumatoid foot, are the risks for postoperative complications. Complications directly associated with the surgery can be avoided by following the principles previously outlined. Careful preoperative evaluation and assessment will help decrease other potential vascular complications Even with adherence to good surgical principles and meticulous surgical technique, complications can still occur. These include wound complications such as dehiscence, hematoma formation, sloughing and postoperative infection. Other postoperative complications directly associated with the type of procedure include fracture of the K-wires, delayed union, nonunion, pseudoarthrosis of an osteotomy or fusion site, and the recurrence of deformities. Some of theses complications will require a minor revisional surgery to correct the problem.

SUMMARY

Surgical reconstruction of the rheumatoid arthritic forefoot is a very serious undertaking. Although most surgeons will agree that the risks are increased due to the physical and metabolic changes imparted by the disease itself, the gratification and rewards of the procedure are also quite tremendous for both the patient and physician. Following the principles and techniques outlined will help ensure the best possible outcome with the least amount of complications.

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