

PAN METATARSAL HEAD RESECTIONS, RHEUMATOID FOOT

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In 1911 Hoffman reported on an operation for severe grades of contracted or clawed toes. His classic description of the deformity of the rheumatoid forefoot is yet to be enhanced.

"The condition", he said, "is practically that of multiple hammertoe, affecting several or, more frequently, all the toes of one or both feet.

"The toes are strongly dorsiflexed (hyperextended) at their metatarsophalangeal joints and plantar flexed at their interphalangeal ones, and are retained in this position by shortening, through adaptation, of tendons, ligaments and other soft structures, and by bone changes due to the long continued new relationship of articular surfaces (Figs. 1A, 1B, 1C).

"The dorsiflexed proximal phalanges articulate at their bases with the dorsal surfaces of the heads or, in many cases, even the necks of their respective metatarsals and, through their vertical position, push the plantar surfaces of the metatarsal heads into the sole. The vertical position of the proximal phalanges also makes the foot much thicker at the front and raises dorsally the plane of the flexed proximal interphalangeal joints. All this gives rise to distress from pressure of the unprotected plantar surfaces of the metatarsal heads and the underlying skin against the shoe sole, and the dorsal surfaces of the flexed interphalangeal joints against the upper leather of the shoe. Large and painful callosities, or occasionally ulcers, form over the pressure areas"(1).

Hoffman recommended resection of all five metatarsal heads through a curved plantar incision made just proximal to the web area (Fig. 2). He stressed the significance of placing the incision at that level as this results in keeping the resulting scar entirely removed from the subsequent stress area of weightbearing.

Numerous other authors have contributed to the popularity of pan metatarsal head resections but have approached the surgery through dorsal incisions, either longitudinal or transverse (2-5).

The faculty of the Podiatry Institute most often approach pan metatarsal resections through five carefully

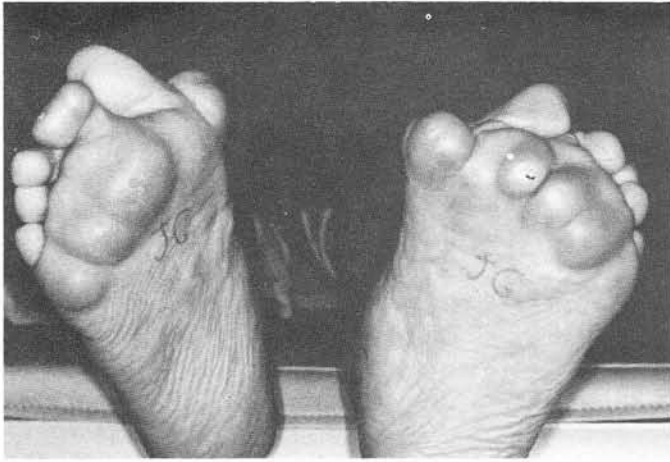
placed dorsal incisions. We have found that the curved transverse plantar incision described by Hoffman is most appropriate in instances where extremes of dorsal contracture of the metatarsophalangeal joints exist. The transverse plantar approach facilitates removal of redundant plantar skin and contributes greatly to maintaining the toes in a functionally corrected position.

Surgical Considerations

One of the concerns with pan metatarsal head surgery is preservation of blood supply. With dorsal transverse skin incisions the blood supply is probably at greatest risk. In that incision the skin incision is transverse while the incision to the individual ray is longitudinal. It is quite easy to injure the longitudinally oriented blood supply with the retraction necessary for exposure of the metatarsal heads. For this reason as well as the fact that the transverse dorsal incision provides less reliable exposure we have totally discontinued use of the dorsal transverse approach.

With the transverse plantar skin incision one is likewise concerned over potential for disturbance of the longitudinally oriented blood vessel and nerve supply to the toes. It should be pointed out that the metatarsal arteries, veins, and nerves lie more nearly between the metatarsal heads rather than within the plantar fat. The transverse plantar skin incision should normally be placed about one and one-half centimeters proximal to the web area. At that level the neurovascular supply is somewhat deeper than is the case at the web level. Furthermore, the incision should be placed through skin and the underlying fat without delving into the interspace areas. By following this routine we have rarely encountered postoperative numbness of the toes and have rarely seen compromise of blood supply.

Five dorsal longitudinal skin incisions are used as our more common approach (Fig. 3). By placing the incisions midline over the metatarsophalangeal joints and the toes the blood supply is spared. By limiting the dorsal extension of the intermediate three incisions to the level of the proximal metatarsal head one avoids creating a long tissue peninsula of tissue which might compromise blood supply. The same incisions extended onto the toes



A



B



C

Fig. 1A, 1B, 1C. Clinical and radiographic views illustrate severe plantar protrusion of metatarsals and dorsal contractures of toes in rheumatoid arthritis patient.

provide convenient access for correction of the digital deformity at the same time.

Regardless of the surgical approach a principle objective is resection of sufficient bone to relieve all soft tissue tension and allow relaxed realignment of the metatarsophalangeal joints. In accomplishing this objective it is important to maintain appropriate relative length of the bones. Hodor and Dobbs, Gerbert and Dobbs, and other authors recommend a length pattern of 2-1-3-4-5 from longest to shortest (4, 5, 6). We concur with that recommendation and feel that it is essential to the retention of equal weightbearing across the entire ball of the foot.



Fig. 2. Hoffman's original approach utilized transverse plantar skin incision. Neurovascular supply to toes was not endangered due to retraction of neurovascular bundles dorsally between metatarsal heads.

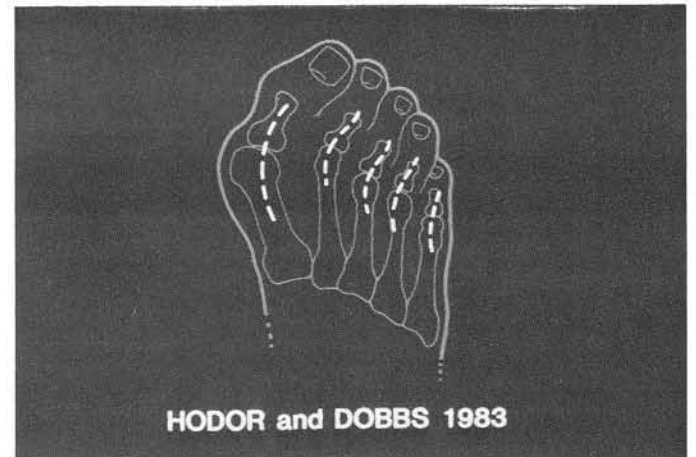


Fig. 3. Hodor and Dobbs recommended five separate dorsal longitudinal skin incisions for pan metatarsal head resections.

Surgical Technique

Plantar Approach

A plantar incisional approach is most appropriate in patients with severe dorsal contracture of the toes and plantar protrusion of the metatarsal heads. In these instances dorsal incisional approaches require excessive soft tissue manipulation (Fig. 4A).

Plantar approach to pan metatarsal head resection is carried out through a curved transverse skin incision approximately one and one-half centimeters proximal to the web spaces (Fig. 4B). The incision extends medially to end at the distal one-third of the first metatarsal shaft. It ends laterally at the distal one-third of the fifth metatarsal shaft. The underlying fatty layer is carefully incised and maintained with the skin. Once the level of the plantar aspect of the flexor apparatus is visualized the flap is dissected free along that plane (Fig. 4C). No attempt should be made to dissect the fatty tissue in the intermetatarsal spaces. That tissue contains the neurovascular structures. Rheumatoid nodules that are encountered are excised easily.

The flexor plate, when present beneath the metatarsophalangeal joints is identified and a longitudinal incision is made medial or lateral to it. More often the flexor apparatus may be found lateral to the metatarsophalangeal joint. Once the joint has been opened longitudinally the metatarsal elevator is used to completely deglove the metatarsal head and neck (Fig. 4D). Once all metatarsal heads have been exposed a premeasured amount of bone is resected including the head of the metatarsal (Fig. 4E). The plantar aspect of the stump is beveled with a power burr.

Most often the first metatarsophalangeal joint is prepared for a hinge implant (Figs. 4F, 4G, 4H, 4I). In that instance an appropriate amount of the proximal phalanx including its base is resected. Implant broaches are used to prepare the desirable sized canals in the metatarsal head and base of the proximal phalanx. The 17mm metatarsal elevator is found most helpful in freeing the phalangeal base and the metatarsal head for resection. Three drill holes are made in the base of the proximal phalanx. One is plantar and the other two are plantar medial and dorsomedial.

Provided no digital procedures are to be performed, Kirschner wires are driven distally out the four lateral toes, then retrograded into the respective metatarsal bones.

Where digital stabilization such as end-to-end or peg-in-hole arthrodesis is to be performed this is carried out

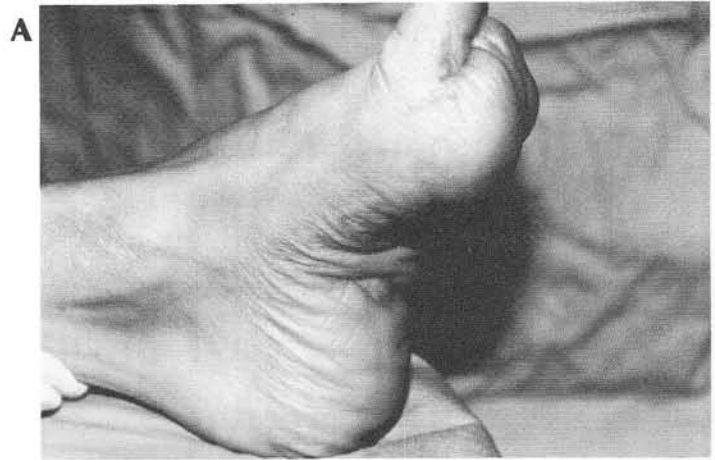


Fig. 4A. Demonstrates foot with severe plantar protrusion of metatarsal heads. This is type foot which demands plantar approach to pan metatarsal head resections.



Fig. 4B. Author's modification of Hoffman plantar skin incision.

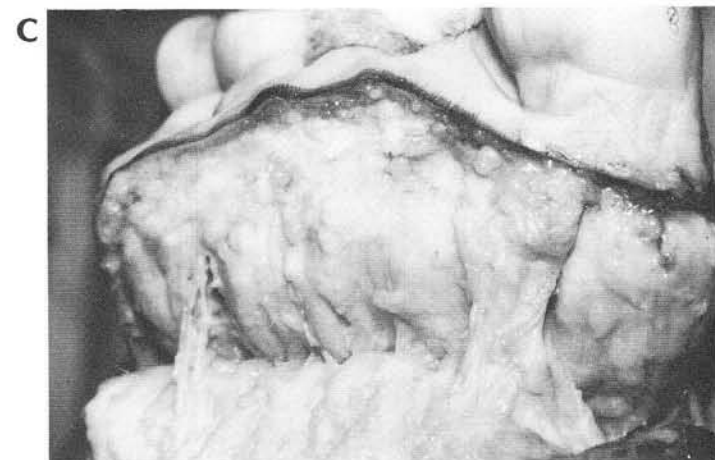


Fig. 4C. Plantar skin flap maintains all fatty tissue attached to skin. Neurovascular structures are well retracted between metatarsals.

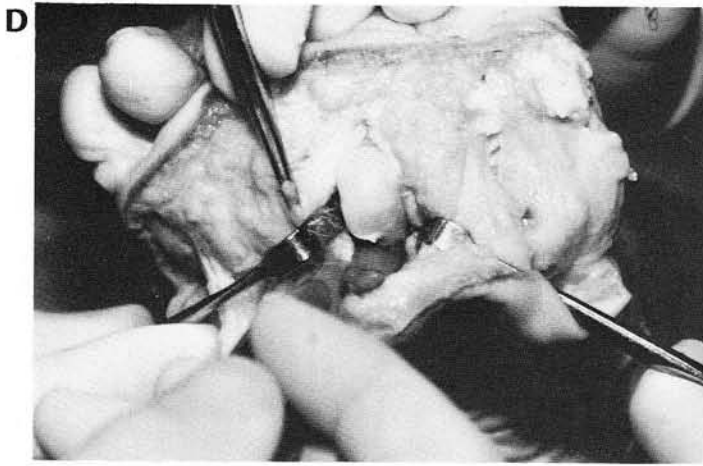


Fig. 4D. Longitudinal incisions are made medial to flexor apparatus and metatarsal elevator is used to deliver head and neck of bone.



Fig. 4E. All metatarsal heads are exposed before any resection is begun. This affords opportunity to better judge relative lengths of resection.

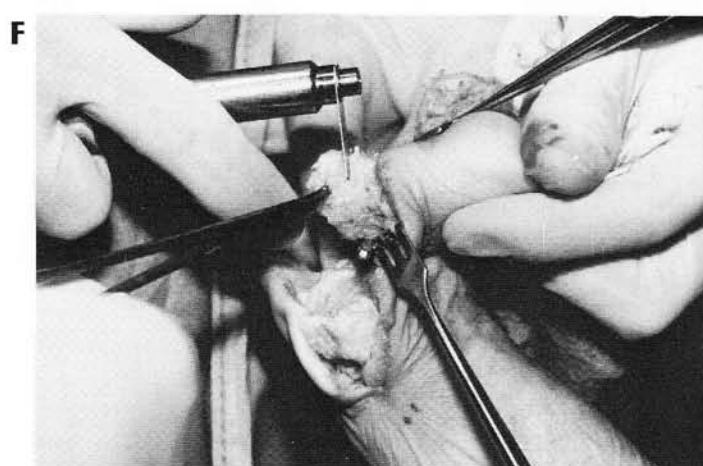


Fig. 4F. Sufficient bone is resected from first metatarsophalangeal joint to accommodate Swanson Hinge implant.

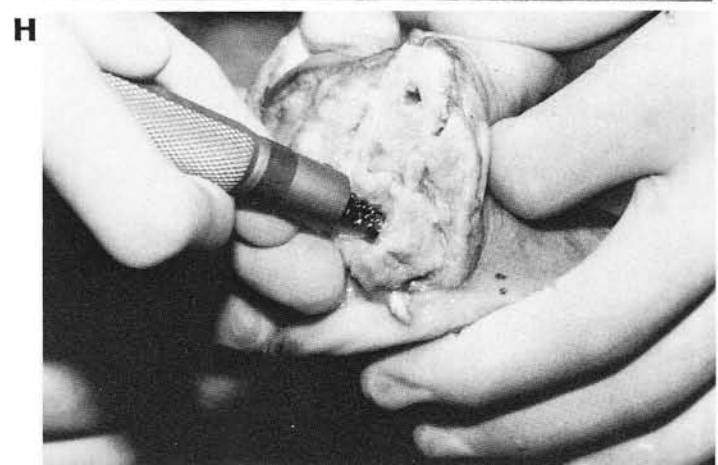


Fig. 4G, 4H. Broaches are used to shape stem canals in phalangeal and metatarsal stumps.

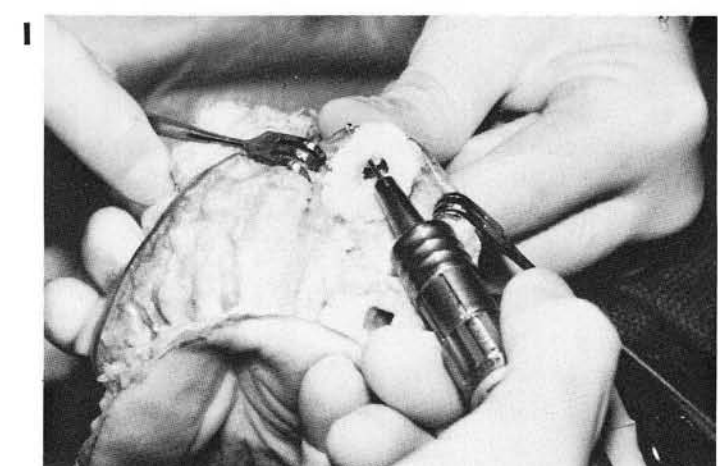


Fig. 4I. Three drill holes are made in base of proximal phalanx, one for reattachment of flexor tendon and two for medial capsular strap.



Fig. 4J. Arthrodesis of middle toes and arthroplasty of fifth toe are commonly combined with pan metatarsal head resections. Same Kirschner wires stabilize toes and metatarsophalangeal joints.

through dorsal incisions on the three middle toes, and often an arthroplasty is performed on the fifth toe. The same Kirschner wires that stabilize the metatarsophalangeal joints also stabilize the four lesser toes (Fig. 4J). Stabilization arthrodesis of the middle three toes is done more often than not. This contributes to maintaining the alignment of the metatarsophalangeal joints.

With the Kirschner wires in place the flexor plate is pulled plantar to the resected joint space and is sutured into position.

Attention is then turned to the first metatarsophalangeal joint. The implant sizer is tried to be certain of fitting and to be sure that no excess tension is present on the implant. After appropriate irrigation sutures are placed to re-attach the flexor brevis and occasionally the longus tendon to the plantar drill hole in the proximal phalanx (Fig. 4K). The medial capsular strap is reattached into the two medial drill holes (Fig. 4L). These sutures are allowed to remain untied.

The implant is seated and the flexor apparatus is replaced and the plantar suture drawn tight and tied. The medial capsular suture is then tightened and tied (Fig. 4M).

The plantar skin and fat flap is stretched into place by an assistant. The excess skin is identified and marked by a sterile skin scribe (Fig. 4N). The excess skin is excised and the plantar flap is closed over a closed suction drain (Figs. 4O, 4P). Interrupted sutures are recommended so as to minimize skin folds in the incision line.

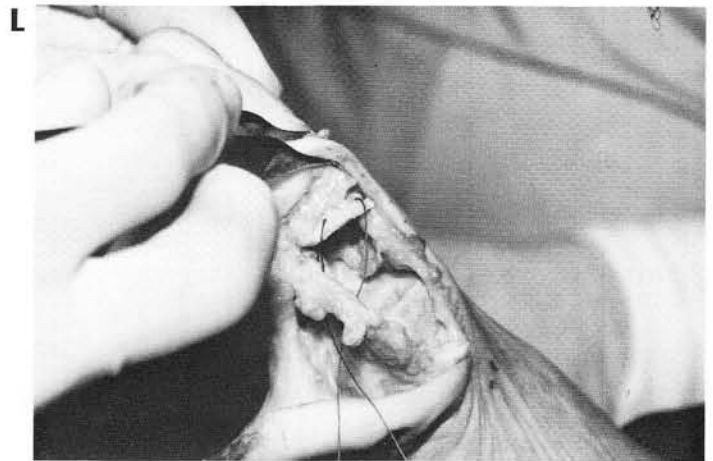
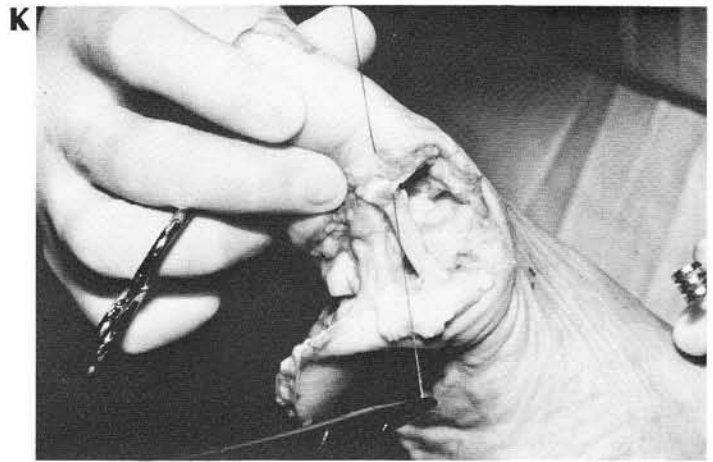


Fig. 4K, 4L, 4M. Closure of first metatarsophalangeal joint includes reattachment of short or long flexor apparatus, reattachment of medial capsular strap, seating of implant, and holding toe in rectus position while previously placed sutures are drawn tight and tied.

Five Dorsal Longitudinal Incision Approach

The five dorsal incision approach to pan metatarsal head resection is most often used in instances of mild and moderate deformity (Fig. 5A). The five incisions are

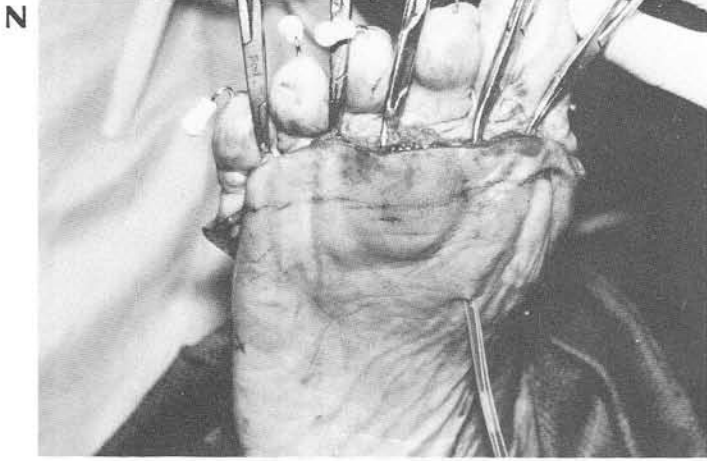


Fig. 4N. Plantar skin flap is drawn forward and redundancy is marked for excision.



Fig. 4O, 4P. After closure of fatty layer skin is closed with tight interrupted sink sutures.

placed near midline over each of the five rays. The first and fifth incisions can be of any appropriate length. But the three middle incisions are kept out on the toes and end no further proximally than the metatarsal head junction with the neck (Figs. 5B, 5C). By keeping the middle three incisions distally placed one avoids long peninsulas of soft tissue that may compromise blood supply.

Through the five incision approach each ray is accessed individually and no ray communicates with any other ray. This approach retains an undisturbed wall of soft tissue between each ray and its neighbor.

The extensor tendons are z-plasty lengthened and retracted. If digital correction is planned the interphalangeal joints are fully opened and the heads of the proximal phalanges delivered. The metatarsophalangeal joints are opened and a metatarsal elevator used to deliver the metatarsal heads. All metatarsals and all toes are exposed before any resection is performed. Metatarsal heads are resected in measured amounts, leaving a length pattern of 2,1,3,4,5 in descending order. The plantar distal metatarsal stumps are smoothed with a rasp or power burr (Fig. 5D). Where the toes are being stabilized the middle three phalangeal heads are resected to peg configuration and fitted into drill holes in the bases of the three middle phalanges. The head of the fifth proximal phalanx is resected. Length pattern of the metatarsals is rechecked before beginning closure.

Kirschner wires (.045) are used to fixate the four lesser toes and metatarsophalangeal joints (Fig. 5E). Tendons are repaired and superficial fascia and skin closed in layers.

The first metatarsophalangeal joint implant is fitted and the flexor tendon and medial capsular flap reattached and closed around the implant (Figs. 5F, 5G, 5H, 5I).

POSTOPERATIVE CARE

A heavy compression dressing is used and the drain (when used) is maintained for 2-4 days until it is no longer productive. At three or four days postoperatively the dressing is changed and a lighter weight but compressive dressing is replaced. In those with a plantar approach we prefer to maintain the foot non weightbearing for three weeks. Where a dorsal approach is used we prefer partial weightbearing for the first ten days. For this reason we recommend surgery on one foot at a time. We have performed the surgery bilaterally and allowed weightbearing in limited amounts from the fourth post operative day. But we feel that the potential for wound complication is greater when allowing early full weightbearing.

A

Fig. 5A. Rheumatoid forefoot with five metatarsophalangeal joint dislocations.

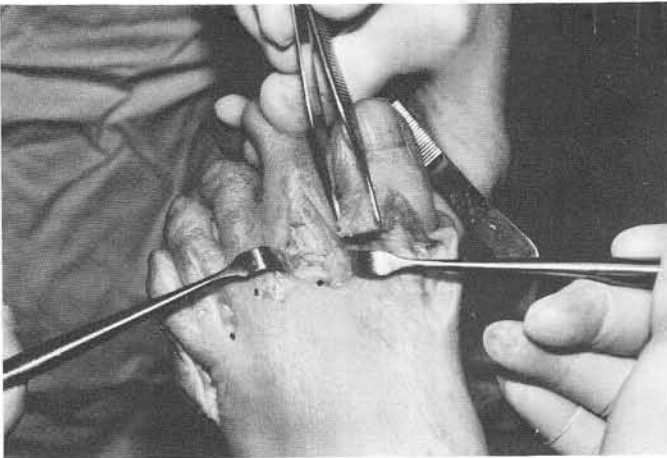
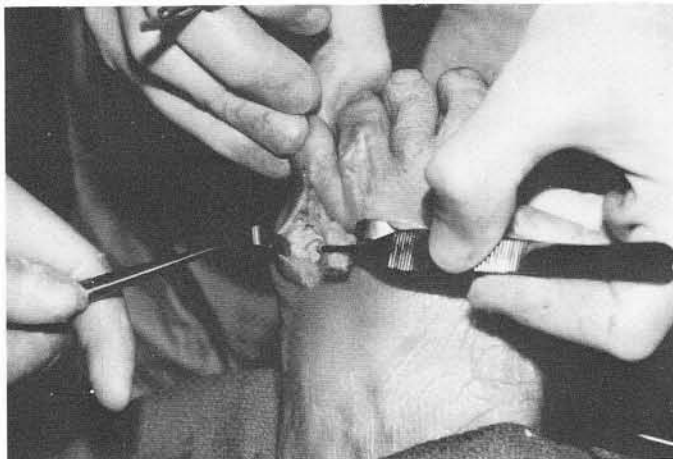
B**C**

Fig. 5B, 5C. Measured amounts of bone are resected from all five metatarsals. Amount resected is planned to preserve weight-bearing relationship of bones.

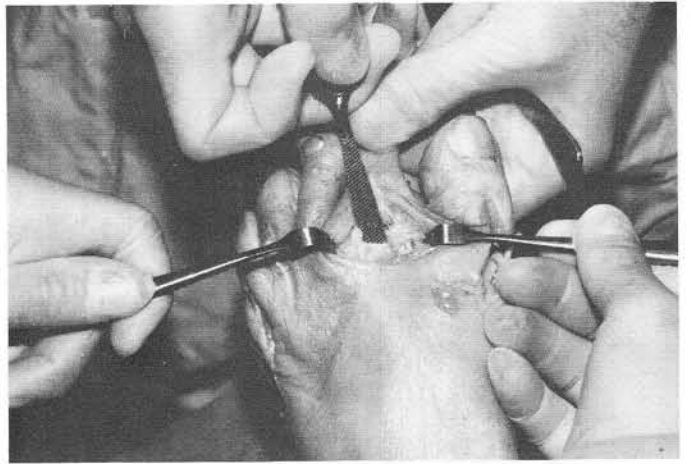
D

Fig. 5D. Distal plantar aspect of metatarsal stump must be carefully smoothed.

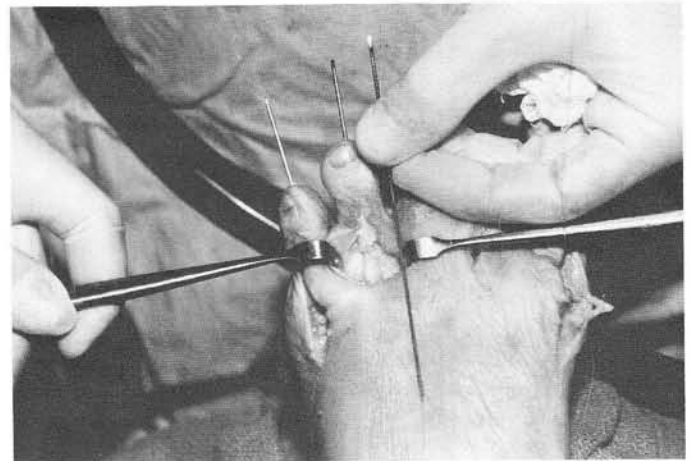
E

Fig. 5E. Kirschner wires are used to stabilize toes and metatarsophalangeal joint alignment.

Kirschner wires are kept in place for a full six weeks if possible. The wires are protected from bending force by a Darco Trauma shoe the insole of which is built up by 1/2 inch thick felt or cork up to the sulcus area beneath the toes. The end of the toe floats over the end of the build-up and is protected from contacting the shoe and from bending force. Typically, celastic or fiberglass splinting is also incorporated into the completed bandage to protect the wires.

Once the wires have been removed the patient begins a period of daily physical therapy at home. Hot baths and underwater exercise of the toes and metatarsophalangeal joints is encouraged several times daily. An elastic bandage from the base of the toes to above the ankle is helpful in controlling and helping to dissipate edema of the forefoot. With the discrete use of external compression bandaging edema is usually beginning to dissipate by 2-3 months postoperatively (Figs. 5J, 5K). Where there is any instability of the toes a molded

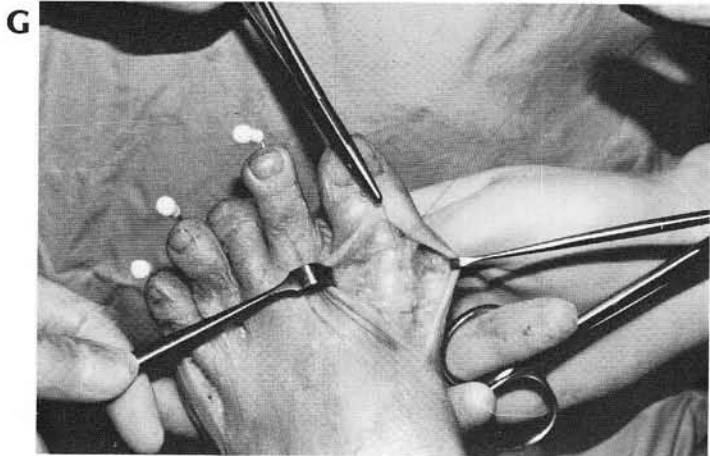
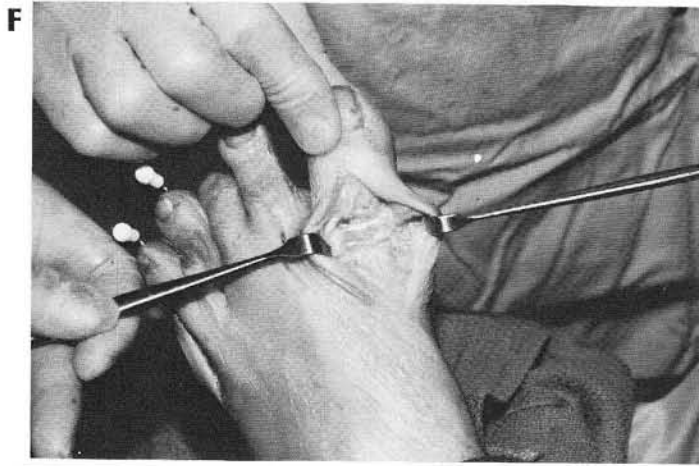


Fig. 5F, 5G. Flexor apparatus is reattached to plantar drill hole in phalanx. Medial capsular strap is reattached into two medial drill holes with suture remaining momentarily untied. Implant is placed and suture securing medial capsular strap drawn tight and tied.



Fig. 5H. All soft tissue closure is done carefully by anatomic layers.



Fig. 5I. Post operative radiograph. Kirschner wires and drain tubes and vacuum tube are seen vaguely outlined.

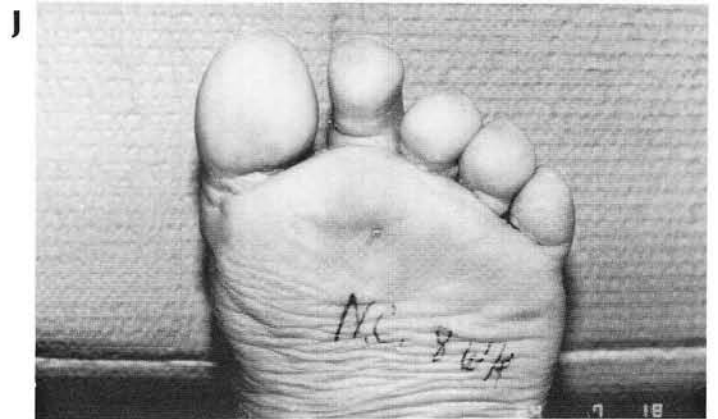


Fig. 5J, 5K. Dorsal and plantar clinical views at eight weeks postoperatively demonstrate resolving edema and very satisfactory alignment.

polyurethane or silicone retainer is prepared for the patient's daytime wear. A hallux valgus night splint can be worn and the patient may bandage the lesser toes to the hallux splint to prevent lateral drift. Such splints may be used for two to three months at night but should be covered with a loose sock to prevent becoming entangled in the bed cover.

Return to shoes should be immediate once the wires have been removed. A depth shoe or a jogging shoe which has a removable insole should be fitted as snugly as possible with the insole removed. In a week or so, as edema decreases the insole is replaced to tighten the shoe. Frequently, other insoles may be needed when the elastic bandage is removed.

A full length latex mould is usually made to a cast of the patient's foot once edema has subsided. A layer of soft butadienne rubber on the upper surface of the forefoot portion of the mould is helpful in obtaining a precise distribution of forefoot pressures. As an alternative, a moulded shoe with a removable plastizote insole will be found effective if the foot is particularly difficult to control in a normal shoe. For dress shoes the patient is asked to purchase the shoe fitted with three extra foam rubber insoles. This provides adequate space for orthopedic padding. The shoes are then brought to the office and the sock liner is temporarily removed. A 1/4 inch thick layer of soft butadienne rubber is cemented to the under side of the forefoot half of the sock liner. The portion beneath the toes is thinned to about one half thickness. The sock liner is replaced in the shoe. After wearing a short period of time this special rubber will take on a 50% memory and will mould very accurately to any pressure areas which may occur. While such patients should be discouraged from constantly wearing dress shoes this routine does permit reasonable wear with comfort while distributing forefoot weight evenly.

Variations In Technique

Quite often digital deformities are so severe and fixed at the interphalangeal joints that they require concomitant correction. For the intermediate three toes we prefer proximal interphalangeal joint arthrodesis. Arthrodesis of the joint provides a stable lever on which the long flexors and extensors can function to help stabilize metatarsophalangeal joint function without causing recurrent deformity of the toes. We avoid arthrodesis of the fifth toe due to the potential for direct shoe irritation. Most often arthroplasty of the fifth toe is combined with arthrodesis of the intermediate three toes.

We avoid resection of the base of the proximal phalanx in the lesser toes where possible, preferring to leave the tendinous attachments to bone undisturbed. Where the

base articular surface is badly distorted we resect a minimal amount of the base in order to straighten the articular end. We agree with Clayton that it is wise to avoid resecting the base of the fifth proximal phalanx since this can lead to a very unstable fifth toe and to difficulty in positioning the toe in stockings and shoes (2).

Discussion and Results

The short term results of pan metatarsal head resections has been quite impressive. While we have seen an infrequent vascular embarrassment when the procedure is performed though three dorsal incisions we have yet to see any such problem when performed through a plantar approach or through the five incision dorsal approach. Obviously the rheumatoid patient is frequently quite compromised in the ability to resist infection so that one needs to minimize trauma of surgery and do all possible to prevent postoperative conditions which would add to susceptibility.

Our long term results have been improved where we have combined procedures to stabilize the toes. It is not uncommon to see a late transfer of pressure to one of the metatarsal ends. For this reason we feel it appropriate to monitor these patients for life and to use supportive measures to maintain equal weight dispersion in the forefoot as well as to control rearfoot function.

Without question, we feel the plantar approach to pan metatarsal head resection is the most practical approach when severe dorsal contractures are present and when it is desirable to remove redundant plantar skin to assist in maintenance of correction of the toes. The plantar flap must be handled carefully and should not be separated from its plantar fatty layer in order to prevent compromise. With careful handling of the plantar flap the plantar approach can be most gratifying and the scar well hidden from view. We have not seen a painful plantar scar from this approach.

Our experience with the five incision dorsal approach has been excellent in surgery on the mild to moderately severe rheumatoid forefoot.

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