

# FIRST METATARSOPHALANGEAL JOINT ARTHRODESIS REVISITED

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Arthrodesis of the first metatarsophalangeal joint (MPJ) was first reported in 1894 by Clutton as a cure for severe hallux valgus, but it was not used much until 1940 when Thompson and McElvenny advocated the procedure in cases of tuberculosis, polio with a marked hallux flexus, hallux valgus, and hallux rigidus.

Twelve years later, Duncan McKeever described his technique for arthrodesing of this joint after having performed bilateral hallux valgus surgery on a patient a number of years earlier, at which time, an infection ensued on one side and resulted in a rigid fibrous ankylosis. Surprisingly, the ankylosed joint was functioning with better result and demonstrated less metatarsus primus adductus. Consequently, McKeever began to use this procedure in cases of hallux rigidus, severe hallux valgus, and metatarsus primus adductus. His technique involved considerable bone resection at the head of the metatarsal so as to form a modified cone with concomitant reaming of the base of the proximal phalanx. A stainless steel screw accompanied by a washer was inserted through the plantar aspect of the proximal phalanx extending through nearly the entire length of the first metatarsal shaft. The angle of the arthrodesis was generally in 15-20 degrees of extension to upwards of 35 degrees in women desiring to wear high heels.

That same year, N. Ross Smith developed an arthrodesing technique aimed at preserving the function of the hallux and allowing the first ray to bear full weight, thus avoiding postoperative lesser metatarsalgia. He advocated maintaining the contoured end length of the metatarsal head by denuding the cartilage down to a convex surface of cancellous bone. The base of the proximal phalanx was treated similarly but producing a concave surface. Fixation in at least 30 degrees of dorsiflexion and 15 degrees of abduction was emphasized to avoid subsequent interphalangeal joint arthritis.

In the years between 1952 to 1980, a variety of surgical techniques were introduced ranging from Harrison and Harvey's Brockman technique to the cone arthrodesis by J.N. Wilson and the peg-in-socket arthrodesis by F.J. Moynihan. Harrison and Harvey's results repeatedly demonstrated a striking improvement in the appearance

of the foot itself, having returned the hallux to a slightly shortened but normal position accompanied by frequently spontaneously corrected lesser digital valgus some months after surgery. The cone arthrodesis first employed the principle of the peg arthrodesis of the interphalangeal joint (IPJ) of the lesser toes and used -24 gauge wire for fixation. The peg-in-socket arthrodesis was nearly identical to the cone arthrodesis with the exception of using an osteotome to first shape the metatarsal head prior to using the reamer. In addition, a screw was used for compression fixation.

Nearly all the work during this time period was done in England, and it was not until 1980 that Roger Mann and J. Oates in the United States performed a retrospective study of 41 arthrodeses over a 5 year period. Their work first brought to light the use of the procedure in previously failed bunion surgery and as an adjunct to the reconstruction of the rheumatoid foot. In addition, this work altered Roger Mann's earlier proposal that a cheilectomy was the procedure of choice for hallux rigidus.

At this same time, there was considerable interest in implant arthroplasty and an eventual lapse of about 4 years where it appears that the arthrodesing procedure fell into disfavor. However, since 1984, there has been renewed interest in the procedure since implant arthroplasties have failed to satisfactorily re-establish the weight-bearing function of the hallux.

It appears that in nearly all cases of successful fusion, either fibrous or bony, overall patient satisfaction (based on function, cosmesis, and pain relief) was rated at approximately 80-90 percent. Less than satisfactory results were related to either malpositioning or IPJ arthritis. In the majority of cases, preoperative metatarsalgia was either improved or alleviated altogether. Hence, the procedure is now enjoying renewed favor and we feel that it is an extremely useful procedure where performed for any of the listed clinical indications (Table 1). The surgical goals in every case are to produce a painless, solid fusion capable of allowing maximum function in propulsion and weightbearing, as well as to produce a foot that can tolerate the fitting of normal shoe gear.

Table 1

## CLINICAL INDICATIONS

- Flail toe
  - Failed implant
  - Neuromuscular imbalance, i.e.:
    - Cerebral palsy
    - Post-polio
    - Arthritic first MPJ
    - Severe hallux valgus
    - Loss of extensor and/or flexor function
    - Inter-articular fracture
    - Previously failed bunion procedure
    - Secondary deformities of other toes
  - Failed Keller
  - Prior infection
  - Hallux limitus
  - Hallux rigidus
  - Rheumatoid arthritis
  - Hallux valgus
- 

As with any surgical procedure, there are a number of relative contraindications such as a limited range of motion of the IPJ; unaddressed secondary deformities which would cause the fusion to fail or increase patient morbidity; poor bone stock or insufficient bone; and certainly taking into account the patient's lifestyle and whether or not having the ability to wear heels greater than two inches in height is important to them. Although most of the literature supports the claim that preoperative IPJ arthritis is a consideration for avoiding this procedure, most authors agree that although this condition may worsen postoperatively, it can be minimized by optimum positioning of the hallux in the transverse plane, especially since Fitzgerald reported that fusion in less than 20 degrees of valgus (abduction) would triple the incidence of developing or exacerbating IPJ arthritis. Certainly, if significant IPJ arthritis is present preoperatively, one should either consider arthrodesing this joint at the time of the initial metatarsophalangeal joint (MPJ) arthrodesis or increase bone resection to functionally shorten the first ray at the risk of developing significant postoperative metatarsalgia. On the other hand, postoperative metatarsalgia can be minimized by decreasing the amount of dorsiflexion of the hallux in the fused position so as to provide the patient with an earlier lift-off via a functionally longer first ray. This decreases the loading across the lesser metatarsals.

One can quickly see that the position of the fusion is more important than the actual procedure used to ensure its end. We believe that the optimum position of arthrodesis should be 20-30 degrees of dorsiflexion and 10-20 degrees of abduction. It is emphasized that there should be no rotation of the hallux on the metatarsal head in either direction so as to avoid the development of ingrown toenails. Less dorsiflexion and abduction can provide a patient with a satisfactory result if the hallux is already short at the time of fusion, i.e., following a failed Keller procedure.

In a patient desiring to wear a heel greater than two inches, more dorsiflexion of the hallux on the metatarsal can be allowed, but again at the risk of developing metatarsalgia postoperatively. The degree of abduction is directly related to the flexibility of the metatarsocuneiform joint. Increased flexibility requires less abduction since one would expect the intermetatarsal angle to decrease postoperatively, especially since the intrinsic muscles have been left intact. Decreased flexibility requires a greater angle of abduction so that the hallux aligns with the second toe. However, too much abduction could lead to possible subluxation of toes two and three. In patients in whom less than 50 percent of the proximal phalanx has been excised in a prior Keller procedure, but in whom no bone graft was interposed, the toe should be fused in slightly less abduction and dorsiflexion in order to achieve greater weight-bearing function of the hallux in stance.

Roger Mann et al reported in 1980, 1984, and again in 1987 their results of retrospective studies of first MPJ arthrodesis as a procedure for failed implants, failed Keller procedures, in rheumatoid arthritis, and in severe hallux valgus. In each study, minimal bone was resected using an oscillating saw so as to preserve as much length of the first metatarsal as possible while maximizing cancellous bone contact. In addition, the fixation method in every case employed two large (threaded) Steinmann pins in a retrograded fashion. The pins paralleled each other from the distal tip of the hallux down the metatarsal shaft. Apparently, the fixation was stable enough to allow weightbearing in a wooden shoe on the second postoperative day.

Surprisingly, out of 75 total cases, only two nonunions and one fibrous union were reported. These cases were the first to demonstrate the success of the fixation technique, contrary to previous fixation techniques employing sliding inlay or intramedullary peg grafts, crossed Kirschner wires (K-wires), circlage wire, screws, staples, chromic suture, and even compression plates and external fixators.

The main disadvantage in these fixation techniques relates to their inability to provide compression or the possibility of causing pain from the devices themselves, necessitating their removal. Other fixation complications have centered around fracture of the metatarsal shaft and/or fracture of the fixation device. With strong compression fixation such as that advocated by Mann et al, as well as by the present authors, it appears that most of the fixation complications can be minimized, even with early weightbearing, although we currently do not advocate weightbearing until radiographic evidence supports bony fusion.

Throughout the literature, many complications relative to first MPJ arthrodesis have been reported (Table 2). Perhaps this is why many surgeons up until now have failed to adopt this procedure as a justifiable correction for severe hallux valgus and hallux rigidus, as well as in reconstructive surgery. Most looked upon the procedure as a joint destructive procedure instead of viewing it as a technique for improving function in weightbearing in the first ray, something a Keller or implant cannot provide. We believe that most of the complications can be avoided if the procedure is performed in the proper patient setting.

The position of arthrodesis directly affects the potential for development of IPJ arthritis, metatarsalgia, ingrown toenails, hallucal callosities, and/or IPKs of the lesser metatarsals, as well as eventual ability to wear normal shoe gear. In no case could we detect any evidence suggesting that this procedure produced a disabling gait or difficulty in maintaining balance, unless of course, the hallux was fused in a plantarflexed position or in a significantly increased dorsiflexed position.

Malunions were second only to IPJ arthritis as the reason for an unsatisfactory result, and related directly to the position of fusion and ability to obtain and maintain compression fixation until solid fusion was present. Although most authors agreed that fibrous unions were not acceptable results, they found most of them to be painless and of little concern to their patients, especially since most patients were able to return to full activity such as running, climbing stairs, and wearing high heels.

Before performing such a procedure on a patient, a number of general surgical considerations should be addressed such as how much shortening of the hallux is wanted or needed, how much first ray lengthening can be expected and how much is needed, what will be the optimum position of fusion in this patient, is there adequate bone stock or should bone grafting be considered, what is the functional demand of the patient as well as his/her overall health, are there any other associated deformities that need to be addressed, how old is the

Table 2

### Reported Complications

- IPJ arthritis
- Nonunion
- Malunion
- Delayed union
- Fibrous union
- Metatarsalgia
- Fracture of the metatarsal shaft
- Plantar-medial callosities
- IPKs of lesser metatarsals
- Ingrown toenails
- Hallux malleus
- Impaired gait or disabling gait
- Difficulty in wearing normal shoe gear
- Balance problems
- Possible subluxation of toes two and/or three
- Painful internal fixation devices
- Infection

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patient, and what can be offered to them should this procedure fail.

The present authors attempt minimal hallux shortening unless other procedures are being performed on the lesser digits and/or metatarsals that would affect the metatarsal parabola as well as the cosmetic appearance of the foot. Up to a point, the longer the first ray is, the more stable it will be and the more effectively it can function in propulsion and weightbearing. If this is a salvage procedure or reconstructive effort, an iliac crest graft may be necessary if too much bone has been previously resected. Otherwise, the fusion is likely to fail in the presence of inadequate bone stock.

The functional demand of the patient is important and should not be overshadowed by the age of the patient. This procedure has been done in young patients in their 20s with exceptionally good results, allowing them to function much better than previously expected. Primarily, that is because this procedure was considered inappropriate for young adults.

The procedure provides increased stability, balance and improved weight distribution at the ball of the foot especially in young cerebral palsy and post-polio patients

and in others with muscular imbalance. This does not imply that it is to be used in all young people with severe hallux valgus and hallux rigidus but merely suggests that it should be considered in light of our previous failures with implants and certain other bunion procedures. The arthrodesis can always be modified to an implant arthroplasty or Keller procedure if it should fail.

One cannot stress enough that failure to address other associated deformities is inviting failure. We advocate the use of other possible ancillary procedures at the same surgical setting (Table 3).

A number of secondary benefits are also possible with the procedure. Oftentimes, lesser digital valgus corrects spontaneously in some months postoperatively. In addition, metatarsus primus adductus diminishes considerably, and by functionally lengthening the first ray, one encourages increased weight distribution and decreased metatarsalgia. We are persuaded that the procedure's advantages (Table 4) significantly outweigh its purported disadvantages (Table 5). A majority of the disadvantages can be overcome by optimum position in fixation at the time of surgery, coupled with a sound patient evaluation preoperatively.

We advocate a dorsolateral skin incision. Minimal bone is resected in an attempt to maintain the weightbearing of the head of the metatarsal and base of the proximal phalanx. We strive for an optimum position of dorsiflexion and abduction without any rotational component, taking care to avoid the creation of a fissure at the plantar-lateral aspect of the hallux. Fixation is achieved primarily by way of a single 3/32 or 5/64 smooth Steinmann pin in a retrograde fashion. Oftentimes, a sesamoidectomy is indicated. A variety of other fixation techniques could also be employed (Table 6).

Table 3

### Possible Ancillary Procedures

- Tibial or fibular sesamoidectomy
- IPJ arthrodesis
- Relocation and arthrodesis of lesser toes
- Possible metatarsal osteotomies
- Possible Hoffman/Clayton procedure
- EHL lengthening
- Excision of IPJ sesamoid
- Excision of rheumatoid nodules

Table 4

### Advantages

- Preserves adductor, short flexor, and extensor digitorum brevis
- Improves cosmetic appearance
- Improves stability
- Improves overall balance and gait
- May maintain position of lesser toes
- Facilitates fitting of normal shoe gear
- Restores weight-bearing function in first ray
- Avoids putting strain on other parts of foot
- May be converted to Keller or implant arthroplasty if procedure fails
- Pain relief
- Simultaneous reduction of intermetatarsal angle

Table 5

### Disadvantages

- May promote arthritic changes at IPJ
- May aggravate pre-existing metatarsalgia
- Optimum position may be difficult to achieve
- Technically more difficult to perform
- Difficulty in kneeling
- May need bone grafting
- Slight shortening of the hallux

Table 6

### Techniques of Fixation

- Kirschner wire(s) or Steinmann pin(s)
- Staple(s)
- Cortical or cancellous screw
- Mini external fixator
- Plates
- Combination

Postoperatively, the patient is maintained non weightbearing in either a short leg cast or surgical shoe for 5-8 weeks. A surgical shoe is then built up from the heel to the sulcus with half-inch felt, and a cutout under the first metatarsal. The patient is allowed to bear weight for the next 2-4 weeks. X-rays are taken every four weeks, and once bony fusion is evident (usually about 6-8 weeks), the Steinmann pin is removed. The patient then gradually returns to normal shoe gear and full weightbearing over the next few weeks in most cases.

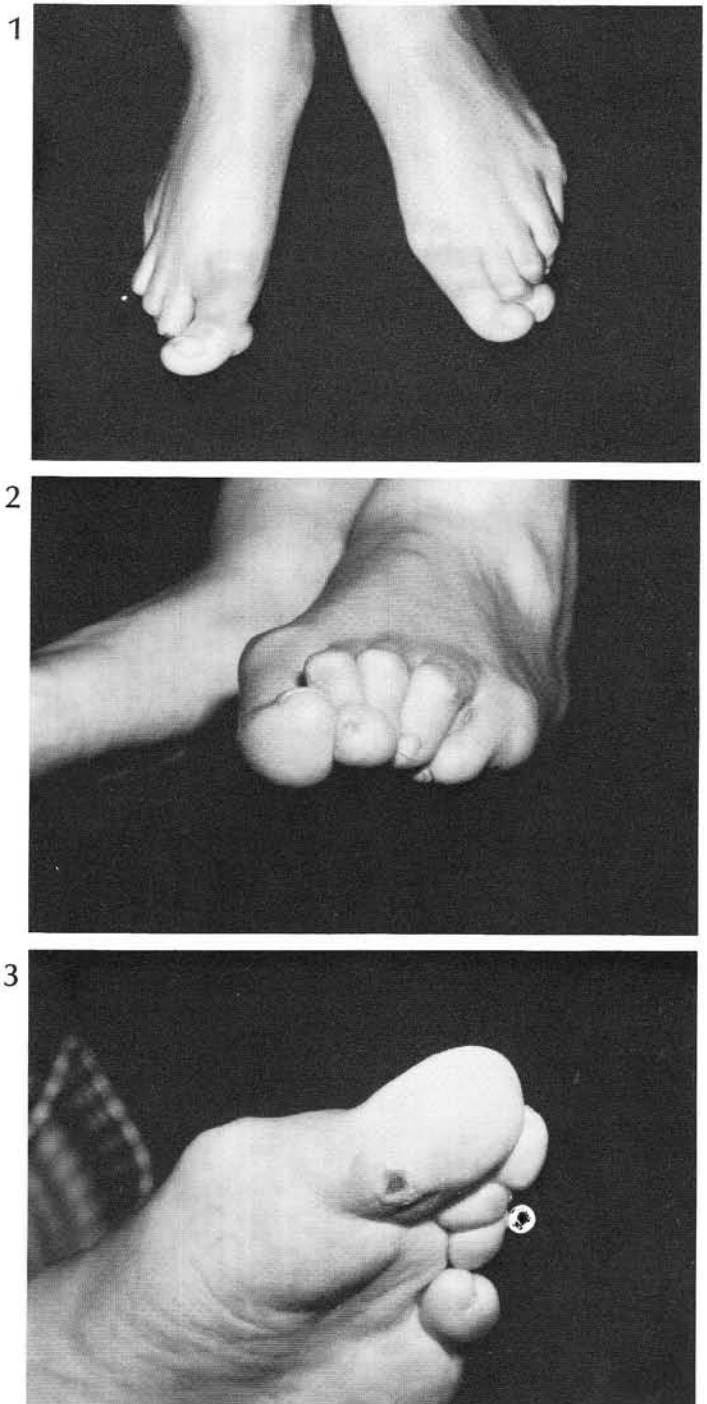
## CASE PRESENTATIONS

### Case Number 1

A 66 year old white female presented in January 1988 to the Cleveland Foot Clinic with a chief complaint of multiple painful nodules and deformities of the digits, especially of the hallux. These caused her disability and discomfort with ambulation in normal shoe gear. The deformities had been present for many years' duration and demonstrated a progressive increase in deformity and symptoms. She has had significant difficulty in obtaining shoes which were comfortable because of the deformities. She expressed a secondary complaint of pain in the right ankle of an intermittent nature. Previous conservative treatment modalities failed to provide significant relief, and she desired a more permanent correction of her deformities.

Her past medical history was unremarkable with the exception of longstanding seropositive rheumatoid arthritis. Previous surgeries included a cervical spine fusion and total hip implant arthroplasty without complications. Current medications included naprosyn, methotrexate, iron supplement and periodic prednisone. No known allergies were reported. The review of systems was remarkable for symptoms relative to her rheumatoid arthritis affecting multiple joints of the axial and peripheral skeleton.

Lower extremity examination revealed multiple inflamed joints of the digits with evidence of spontaneous fusion of the several interphalangeal joints. Multiple rheumatoid nodules were noted in both feet including a rather large nodule beneath the IPJ of the great toe of both feet. A superficial ulceration was also noted over several of the lesser digits and the plantar aspect of the left hallux. The texture, turgor, and color of the skin was otherwise unremarkable and consistent with longstanding rheumatoid arthritis. No evidence of active vasculitis was noted. Hair growth was sparse. Mild dystrophic changes of the nails were noted. Plantar tylomas were absent except beneath the fifth metatarsal (Figs. 1-3).



**Figs. 1, 2, 3.** Preoperative clinical appearance. Note multiplanar deformity of the toes, pre-ulcerative plantar lesion of the great toe with fixed hyperextension deformity at the IPJ and flexion at MPJ.

The neurovascular status was essentially within normal limits. The pedal pulses were intact and palpable bilaterally. The temperature gradient was within normal limits. Capillary fill time was normal. A few telangiectasias and venectasias were noted and considered consistent with her age. Epicritic sensation was essentially within normal limits. All intrinsic and extrinsic musculature appeared intact. No gross weakness was identified.

Orthopedically, the ankle joint revealed a significantly decreased range of motion of the right foot with some crepitus noted. Subtalar joint motion of the right foot was absent and grossly decreased in the left foot. The midtarsal joints showed decreased range of motion without pain or crepitation bilaterally. Primary deformities in the forefoot included multiple sagittal and transverse plane deformities of the lesser digits in the left foot.

The lesser digit deformities in the right foot were primarily in the sagittal plane only. Motion was absent at the fourth MPJ of the left foot, and appeared clinically to be fused. Motion at the remaining lesser MPJs was normal and without pain or crepitation. No motion was present at the IPJ of the great toe of the left foot, which had undergone spontaneous fusion in approximately 30-40 degrees of hyperextension. The range of motion of the first MPJ was grossly restricted. Less than 20 degrees of dorsiflexion was present, with approximately 10 degrees of plantarflexion. Range of motion was painful at its end range and was abrupt. A mild hallux valgus was noted with a medial bunion prominence.

In relaxed stance, the deformities were essentially unchanged. The patient's gait was essentially apropulsive and moderately antalgic.

Standard radiographic views were consistent with the clinical findings. There were marked digital contractures in both the transverse and sagittal planes of the left foot and primarily the sagittal plane of the right foot. The IPJ of the left great toe was completely arthrodesed with no evidence of a joint space present. There was a slight joint space noted in the same joint in the right foot. The ankle joint showed significant degenerative arthritis. Subtalar joint of the right foot showed complete consolidation and minimal joint space was present in the left foot. The midtarsal joint showed significant arthritic changes as well (Fig. 4).

The patient subsequently underwent surgical correction of her multiple forefoot deformities of the left extremity. The proposed surgical procedures of the first ray included a total implant arthroplasty of the first metatarsophalangeal joint and arthrodesis of the IPJ of the great toe. Intraoperatively, the quality of the bone



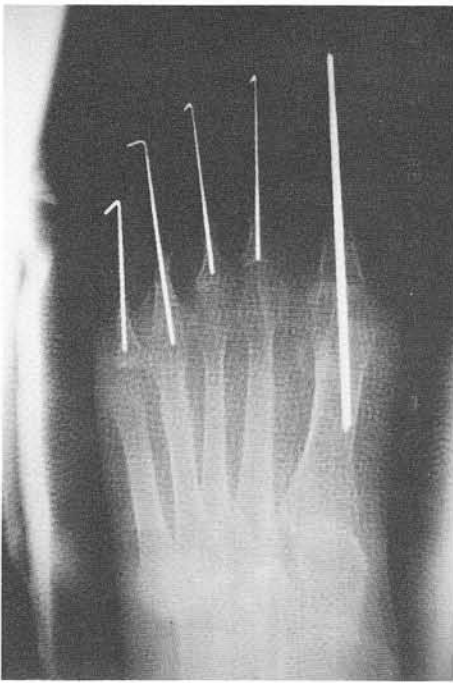
Fig. 4. Preoperative dorsoplantar x-ray of the left foot.

was found extremely poor. It was felt to be too soft to support a total implant. The decision was then made to perform arthrodesis of both the IPJ and the MPJ of the first ray.

Because a pan-metatarsal head resection was not to be performed, the majority of bone resection was accomplished on the phalangeal side of the joint. An attempt was made to preserve maximum length and weightbearing to the first metatarsal, thus avoiding significant transfer lesion potential. The MPJ was arthrodesed in a slightly dorsiflexed position. Transverse plane correction was also accomplished. The IPJ was osteotomized, appropriate wedge resection of bone performed to correct for the severe extension deformity, and both joints were stabilized with a single Steinmann pin. Arthrodesis of the proximal IPJs of the lesser digits was performed, as well as a partial fifth metatarsal head resection and excision of multiple rheumatoid nodules (Figs. 5, 6).

Her postoperative course was unremarkable and uneventful. She was maintained in a non weight-bearing status for approximately 6 weeks, at which time the Steinmann pins and K-wires were removed uneventfully. Physical therapy was instituted to resolve edema. Balance-mold orthotic devices were fabricated.

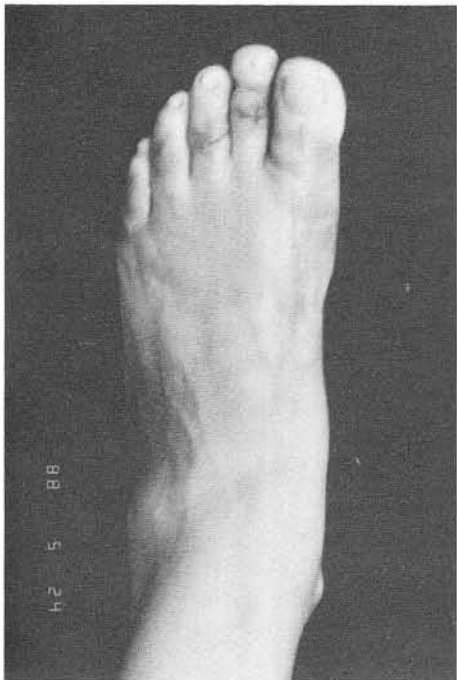
Eight months postoperatively, she is completely asymptomatic in the left foot and is able to ambulate and bear weight pain-free. Clinically, there is no discernible motion present at the IPJ or MPJ of the great toe. There are



**Fig. 5.** Immediate postoperative x-ray.



**Fig. 6.** Clinical appearance 3 days postoperatively.



**Fig. 7.** Clinical appearance 6 months postoperatively.



**Fig. 8.** Radiographic appearance 4 months postoperatively.

no plantar lesions present, and the alignment of the foot is excellent. She continues to have motion present at the second, third, and fifth MPJs but no motion at the fourth from prior spontaneous fusion (Figs. 7, 8).

### Case No. 2

A 49 year old white female presented to the Cleveland Foot Clinic in April 1988 for consultation regarding a

severely painful first metatarsophalangeal joint of the left foot. Pain was described as being a dull ache with occasional bouts of sharp pain. She had noted excessive stiffness to movement of the great toe. She related having undergone previous foot surgery approximately 8 months prior to her consultation, at which time a distal metaphyseal osteotomy of an unspecified nature was performed to correct a hallux abducto valgus deformity. She was seeking a more permanent correction of her deformities.

Past medical history was essentially unremarkable and noncontributory. Previous surgeries included a cholecystectomy and multiple foot surgeries for plantar fasciitis and heel spur syndromes, as well as ingrown

nails. These surgeries were performed without complications. No allergies were reported. She denied taking any medications with the exception of Tylenol for foot pain. She admitted to nicotine and ethanol consumption on a social basis only.

Physical examination revealed a postsurgical cicatrix over the first MPJ of the left foot, as well as the medial aspect of the heel. Dystrophic hallux nails were noted bilaterally. Texture, turgor, and color of the skin was otherwise unremarkable. Hair growth was present. Mild plantar tylomas were noted beneath the second, third, and fourth metatarsals of both feet.

Neurovascular status was within normal limits. The pedal pulses were intact bilaterally. Capillary fill time was within normal limits. A normal temperature gradient was present. Epicritic sensation was normal. Extrinsic and intrinsic musculature was intact.

Significant findings of the orthopedic evaluation included a dorsiflexion contracture at the metatarsophalangeal joint and plantarflexion contracture of the interphalangeal joint of the left great toe. Crepitation was noted upon passive range of motion of the first MPJ, which was grossly restricted. The total range of motion was approximately 20 degrees. No plantarflexion was obtainable. In a maximally plantarflexed position, the toe stopped at approximately 20 degrees of dorsiflexion. End ranges of motion were extremely abrupt. Biomechanically, the first metatarsal was elevated above the level of the second, third, and fourth. No movement was discernible at the previous osteotomy site. Both distraction and compression of the joint were painful. Clawtoe contractures of the lesser digits were noted bilaterally with moderate contractures at the level of the MPJs. There was splaying between the first and second metatarsals. Range of motion of the first ray was essentially normal.

In relaxed stance position a hallux abducto valgus deformity was noted. The hallux demonstrated no ground purchase. Gait cycle was markedly antalgic with an obvious limp present.

Standard radiographic views were consistent with the clinical findings. The primary finding was a malunion of the capital fragment of the first metatarsal head with a grossly overcorrected proximal articular set angle. The joint showed degenerative arthritis, particularly in the base of the proximal phalanx. Evidence of an osteotomy was demonstrated by a radiolucent line still apparent through the metatarsal head. Significant shortening of the first metatarsal was noted. Stress dorsiflexion and distraction views of the first MPJ failed to demonstrate movement within the osteotomy site (Fig. 9).



**Fig. 9.** Preoperative dorsoplantar x-ray of left foot. Note shortening of first metatarsal, overcorrection of the proximal articular set angle, recurrent hallux abducto valgus, metatarsus primus varus, and degenerative arthritis of first metatarsophalangeal joint.

Tomograms and CAT scans of the first metatarsal were subsequently obtained and interpreted as a probable nonunion or incomplete union of the distal capital fragment.

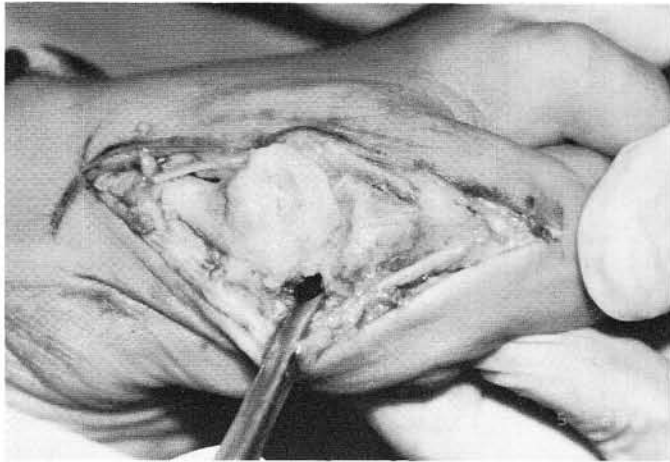
After extensive evaluation, it was felt that several options for correction of her problems should be considered. Although the malunion of the first metatarsal osteotomy was felt to be a strong contributing factor to the severe hallux limitus deformity, it was obvious that correction of this problem would fail to resolve the hallux limitus in light of the other radiographic and clinical findings. Furthermore, correction of the deformity would require autogenous bone graft and, therefore, prolonged convalescence.

Total implant arthroplasty, although a possible alternative, was felt to be inappropriate because of the potential for weight-bearing function of right first metatarsal and subsequent metatarsalgia and transfer lesions to the adjacent metatarsals. This was a special consideration in light of the fact that the first metatarsal already demonstrated significant shortening. Arthrodesis of the first MPJ was felt to be the most viable reconstructive approach with the least associated recovery time. After extensive consultation with the patient, surgical correction was undertaken. Arthrodesis was selected as the most viable option.

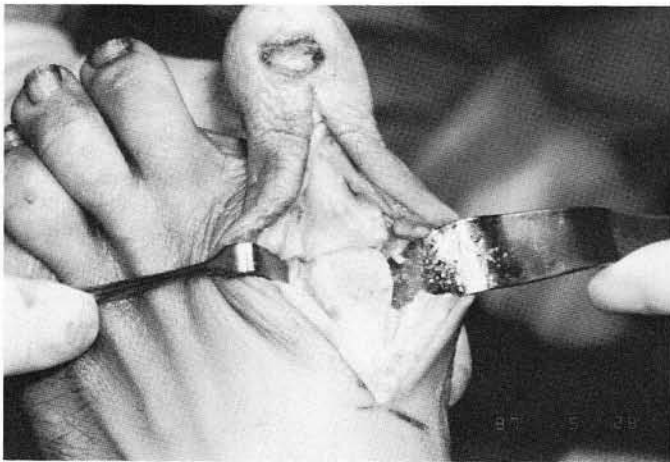


Intraoperatively, the distal metatarsal osteotomy site was noted to be satisfactorily healed. The distal fragment was clearly grossly dorsiflexed, rotated, and overcorrected with the distal articular surface facing medially (Fig. 10). In an attempt to accomplish arthrodesis with a minimum of shortening, the articular surfaces were resected using hand instrumentation and power burrs. An attempt was made to maintain the normal anatomic contour of the joint in accomplishing fusion (Fig. 11). The intermetatarsal angle was readily reduced and the hallux maintained in the desired position. The IPJ of the great toe was also arthrodesed in a neutral position. The entire first ray was stabilized using a single K-wire (Fig. 12). Intraoperative x-rays were taken to confirm satisfactory alignment and position of the arthrodesis.

Postoperative course was unremarkable. She was maintained in a non weight-bearing status initially for 8 weeks. She was then placed in a postoperative surgical shoe with guarded weightbearing for an additional 2 weeks. Serial



**Fig. 10.** Intraoperative appearance of the first metatarsal. Note grossly altered alignment of capital fragment.



**Fig. 11.** Intraoperative appearance following resection of joint surface attempting to maintain normal convex and concave surface of first metatarsal head and phalangeal base.

x-rays showed a delayed consolidation of the arthrodesis site. The K-wire was removed at 8 weeks postoperatively. The most recent x-rays demonstrated a probable nonunion of the first MPJ arthrodesis site. The joint space line was still visible on x-ray. The range of motion of the joint was approximately 5-10 degrees but was entirely without pain or crepitus.

At six months postoperative, she is able to perform all her normal daily activities and ambulate without pain. She does admit to a difficulty in squatting due to the lack of motion in the joint. There is no residual pain or swelling noted. The overall cosmetic appearance is excellent. The patient is extremely satisfied with the outcome of the surgery (Fig. 13).

### Case No. 3

This 69 year old white female presented in July 1987 to the Cleveland Foot Clinic with a chief complaint of



**Fig. 12.** Intraoperative appearance following stabilization of both interphalangeal and metatarsophalangeal joints with single 0.062" K-wire.



**Fig. 13.** Clinical appearance 5 months postoperatively. Hallux does not purchase ground supporting surface in order to facilitate gait. Note absence of flexion contraction at IPJ which was prevented by simultaneous fusion.

constant aching and throbbing pain in both feet, particularly in the great toes and in the medial arch of the left foot. The patient related a longstanding history of having undergone multiple foot surgeries of the lesser digits and first ray over a period of 16 years. The number of surgeries had been so extensive that she had lost track of both her attending surgeons as well as the sequence of procedures performed. She stated that the pain present in her great toes and forefoot had been present since these surgeries and had increased with time.

The patient's symptoms were particularly aggravated by walking in normal shoe gear. She stated that she was unable to walk more than 50 yards at a time without severe pain. Following that, she would be exhausted. Walking was a tremendous chore for her. She also requested amputation of her fifth toe of the right foot because of complete instability and flailness of the digit. She reported the use of narcotic analgesic medications to control her pain at times. She was desirous of a more permanent surgical correction for the great toe problem.

Her past medical history was remarkable for hypertension of longstanding duration which was well controlled by maxzide. Previous surgeries and hospitalizations were rather extensive and considered noncontributory with regard to the present problem, except for the foot surgery as noted previously. Allergy to codeine was reported. Current medications included percodan for pain in her feet on an occasional basis. Her family history and social history were noncontributory.

The lower extremity examination revealed multiple grotesque deformities of the forefoot bilaterally. Plantar tylomas were noted beneath the first metatarsophalangeal joints bilaterally. Irritation over several IPJs of the lesser digits was also noted. Multiple postsurgical scars were noted with significant contracture and adhesions. Texture, turgor, and color was otherwise satisfactory for her age. Sparse hair growth was present.

The neurovascular status of the foot was within normal limits. The pedal pulses were intact bilaterally. Temperature gradient was normal. Capillary fill time was normal. No atrophic ulcerations were present. Epicritic sensation was essentially within normal limits. Muscle evaluation revealed inability to actively contract the tibialis anterior of the left foot. In addition, there was no flexion power discernible in either great toe. Severe contracture of the extensor hallucis longus (EHL) tendon was noted.

Orthopedic findings were significant for total collapse of the medial longitudinal arch of the left foot. Both halluces demonstrated severe dorsiflexion contracture at the metatarsophalangeal joint. A severe limitation to

ankle joint dorsiflexion was noted on both feet. The subtalar and midtarsal joints showed flexible range of motion without pain or crepitus. Multiplanar deformities were present in the lesser digits with nonpurchase of several of the lesser digits. The fifth toe of the right foot was flail.

Standard radiographs of the feet were obtained and were consistent with the clinical findings (Fig. 14). Significant degenerative arthritis was present throughout the midfoot and forefoot areas. Severe evidence of pronatory deformity of midfoot and rearfoot were evidenced. Both halluces were noted to be severely dorsiflexed at approximately 60 degrees. Other forefoot deformities were confirmed as evidenced clinically.

Surgical reconstruction targeted her main complaint of the hallux. Because of the excessive shortening and atrophy of the proximal phalanx of the great toe and loss of flexor power it was felt that total implant arthroplasty was not a viable alternative. First metatarsophalangeal joint arthrodesis was recommended with lengthening of the extensor tendon. The patient was advised that the goal of the surgery would be to eradicate or significantly decrease the pain, as well as improve the cosmetic and functional alignment of the great toe.

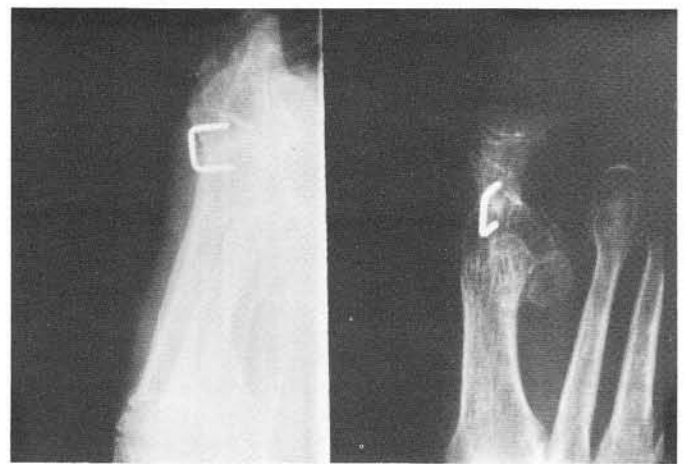
The patient was subsequently taken to surgery, where first metatarsophalangeal joint arthrodesis of the right foot was performed and fixated with axially placed Kirschner wires (K-wires). In addition, a small scaphoid staple was inserted to prevent distraction of the joint during the healing process. Intra-operatively, the proximal phalanx was noted to be extremely altered from its normal configuration. Bone stock was extremely poor, and it was clearly evident that it would not be able to support an implant based upon the size of the phalanx alone. The extensor tendon was lengthened in a Z-plasty manner. In addition, a fifth digit amputation and revisional fifth metatarsal head resection were also performed.

Postoperatively, the patient was maintained in a non weight-bearing status for a period of 8 weeks, at which time the K-wires were removed. The scaphoid staple was permitted to remain in place. Physical therapy was instituted to eliminate postoperative edema. The patient was permitted to ambulate in a Reese shoe for two weeks and subsequently returned to normal shoes as tolerated.

One year postoperatively, the patient is without complaints with regard to the great toe of the right foot. The toe presently does not purchase the ground, has been fused in a position of dorsiflexion and abduction and is completely functional without disability. There is no discernible motion present in the interphalangeal joint



**Fig. 14.** Preoperative dorsoplantar x-ray. Note excessive shortening and alteration of metatarsophalangeal joint and proximal phalanx.



**Fig. 15.** Radiographic appearance 4 months later.

or the metatarsophalangeal joint of the great toe. Surgical correction of the left foot deformity is anticipated in the near future (Figs. 15-17).

### SUMMARY AND CONCLUSIONS

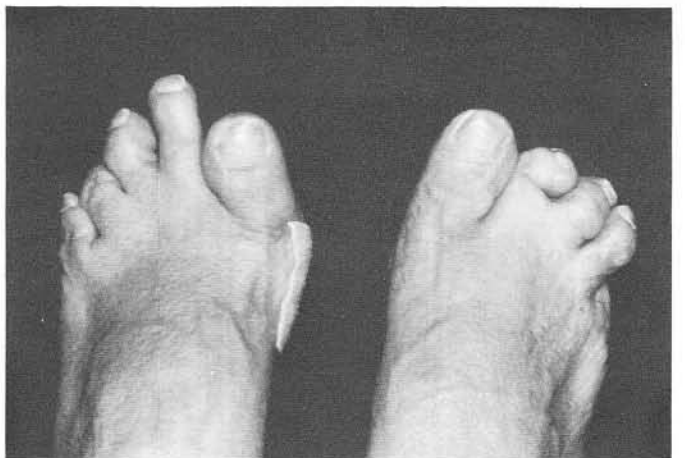
First metatarsophalangeal joint arthrodesis appears to be a procedure that has a significant role in surgical reconstruction of forefoot deformities. Our limited experience indicates that it is particularly valuable in reconstructive salvage surgery in situations where an overaggressive Keller has been performed, where there is loss of intrinsic and extrinsic muscle function, and where implant arthroplasty is contraindicated or not desirable. Like implant arthroplasty, arthrodesis provides excellent stability to the joint. The arthrodesis technique is amenable to a variety of internal fixation techniques. Simple stabilization techniques using K-wires, Steinmann pins, and/or staples appear to be satisfactory. The incidence of postoperative complications appears to be minimal.

The desired position of fusion is generally one of slight dorsiflexion and abduction. This most readily facilitates near-normal patterns. In situations where the lesser digits show excellent stabilization and alignment, the degree of transverse plane abduction would be lessened. Failure to fuse the toe in a position of dorsiflexion could cause great difficulty with gait patterns. The degree of dorsiflexion needed is dependent upon the style and type of shoe gear to be worn by the patient. Patients desiring to wear higher heeled stylish shoes should certainly be fused in a position of greater dorsiflexion.

Patient selection for a first metatarsophalangeal joint arthrodesis is critical. Patients who lead a very active lifestyle and are extremely propulsive and dynamic in



**Fig. 16.** Clinical appearance 6 months postoperatively.



**Fig. 17.** Correction of lesser digits was not attempted due to risk of impending loss considering numerous prior procedures of lesser toes. Amputation of fifth toe was performed.

their gait patterns may not be candidates for arthrodesis. Consideration should be given for other procedures which preserve motion at the metatarsophalangeal joint.

Potential complications of the surgery are similar to those of other arthrodesing procedures and include delayed union-nonunion-pseudoarthrosis, malunion, infection, persistent pain and edema, and alteration of the normal physical appearance. These do not appear to be common if patient selection is done carefully and the procedures executed properly. Postoperative management should include non weightbearing for a period of 6-8 weeks until radiographic consolidation is demonstrated.

The authors feel that this is a procedure which has great merit and should be given consideration when reconstructive surgery of the first ray is performed.

### References

- Beauchamp CG, Kirby T, et al: Fusion of the first metatarsophalangeal joint in forefoot arthroplasty. *Clin Orthop* 190:249-253, 1984.
- Chana GS, Andrew TA, et al: A simple method of arthrodesis of the first metatarsophalangeal joint. *J Bone Joint Surg* 66B:703-705, 1984.
- Cohn I, Kanat IO: Functional limitation of motion of the first metatarsophalangeal joint. *J Foot Surg* 23:477-484, 1984.
- Coughlin MJ, Mann RA: Arthrodesis of the first metatarsophalangeal joint as salvage for the failed Keller procedure. *J Bone Joint Surg* 69A:68-74, 1987.
- Drago JJ, Oloff L, et al: A comprehensive review of hallux limitus. *J Foot Surg* 23:213-220, 1984.
- Favreau JC, LaBelle P: Hallux valgus and hallux rigidus. In Proceedings of Canadian Orthopaedic Association. *J Bone Joint Surg* 39B:792-793, 1957.
- Fitzgerald JAW, Wilkinson JM: Arthrodesis of the metatarsophalangeal joint of the great toe. *Clin Orthop* 157:70-77, 1981.
- Fitzgerald JAW: A review of long-term results of arthrodesis of the first metatarso-phalangeal joint. *J Bone Joint Surg* 51B:488-493, 1969.
- Ginsburg AI: Arthrodesis of the first metatarsophalangeal joint. *J Am Podiatry Assoc* 69:367-369, 1979.
- Goldner JL: Hallux valgus and hallux flexus associated with cerebral palsy: analysis and treatment. *Clin Orthop* 157:98-104, 1981.
- Harrison MHM, Harvey FJ: Arthrodesis of the first metatarsophalangeal joint for hallux valgus and rigidus. *J Bone Joint Surg* 45A:471-480, 1963.
- Hattrup SJ, Johnson KA: Hallux rigidus: a review. *Advances in Orthopaedic Surgery*. Mayo Foundation, 1986.
- Lipscomb PR: Arthrodesis of the first metatarsophalangeal joint for severe bunions and hallux rigidus. *Clin Orthop* 142:48-54, 1079.
- Mann RA, Thompson FM: Arthrodesis of the first metatarsophalangeal joint for hallux valgus in rheumatoid arthritis. *J Bone Joint Surg* 66A:687-692, 1984.
- Mann RA, Oates JC: Arthrodesis of the first metatarsophalangeal joint. *Foot Ankle* 1:159-166, 1980.
- Mann RA, Coughlin MJ, Duvries HL: Hallux rigidus: a review of the literature and a method of treatment. *Clin Orthop* 142:57-63, 1979.
- Marin GA: Arthrodesis of the first metatarsophalangeal joint for hallux valgus, hallux rigidus. *Guy's Hospital Report* 109:174, 1960.
- McKeever DC: Arthrodesis of the first metatarsophalangeal joint for hallux valgus, hallux rigidus, and metatarsus primus varus. *J Bone Joint Surg* 34A:129-134, 1952.
- Moynihan FJ: Arthrodesis of the metatarsophalangeal joint of the great toe. *J Bone Joint Surg* 49B:544-551, 1967.
- Phillips JE, Hooper G: A simple technique for arthrodesis of the first metatarsophalangeal joint. *J Bone Joint Surg* 68B:774-775, 1986.
- Riggs SA, Johnson EW: McKeever arthrodesis for the painful hallux. *Foot Ankle* 3:248-253, 1983.
- Salis-Soglio G von, Thomas W: Arthrodesis of the metatarsophalangeal joint of the great toe. *Arch Orthop Traumat Surg* 95:7-12, 1979.
- Smith NR: Hallux valgus and rigidus treated by arthrodesis of the metatarsophalangeal joint. *Brit Med J* Dec, 1952.
- Sussman RE, Russo CL, et al: Arthrodesis of the first metatarsophalangeal joint. *J Am Podiatr Med Assoc* 76:631-635, 1986.
- Sykes A, Hughes AW: A biomechanical study using cadaveric toes to test the stability of fixation techniques employed in arthrodesis of the first metatarsophalangeal joint. *Foot Ankle* 7:18-25, 1986.
- Thompson FR, McElvenny RT: Arthrodesis of the first metatarsophalangeal joint. *J Bone Joint Surg* 22:555-558, 1940.
- Wilson JN: Cone arthrodesis of the first metatarsophalangeal joint. *J Bone Joint Surg* 49B:98-101, 1967.