# FIRST METATARSOPHALANGEAL ARTHRODESIS REVISITED - AN UPDATE

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In 1989, the authors presented a comprehensive overview of first metatarsophalangeal joint arthrodesis in the management of forefoot deformities. This can be found in the Podiatric Education and Research Institute, *Reconstructive Surgery of the Foot and Leg, Update '89.*

The authors have continued to use this procedure and have found it to be very valuable in the management of challenging forefoot cases, especially those involving major reconstructive surgery or revisional surgery. We have also utilized this procedure in the management of the rheumatoid forefoot deformities as an alternative to total implant arthroplasty, Keller bunionectomy, or 1st metatarsal head resection. The purpose of this paper is to present three additional cases demonstrating the effectiveness of this procedure.

The clinical indications, reported complications, possible ancillary procedures, advantages, disadvantages, and techniques of fixation are summarized in the following tables.

## TABLE ONE

### Clinical Indications

* Flail toe
* Failed implant
* Neuromuscular arthroplasty disease
  - Cerebral palsy
  - Post-polio
* Arthritis/Gout
* Severe hallux valgus
* Loss of extensor and/or flexor function
* Intra-articular fractures
* Previously failed bunion procedure
* Failed Keller
* Prior infection/septic Arthritis
* Hallux limitus/rigidus
* Rheumatoid arthritis

## TABLE TWO

### Reported Complications

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

## TABLE THREE

### Possible Ancillary Procedures

* Tibial or fibular sesamoidectomy
* IPJ arthrodesis
* Relocation and arthrodesis of lesser toes
* Possible Hoffman/Clayton procedure
* EHL lengthening
* Excision of IPJ sesamoid
* Excision of rheumatoid nodules
* Base Wedge osteotomy

## TABLE FIVE

### Advantages

* Preserves adductor, short flexor, and extensor digitorum brevis
* Improved cosmetic appearance
* Improved stability
* Improved overall balance and gait
* Improved position of lesser toes
* Allows normal shoe gear
* Restores/maintains weight-bearing function in first ray
* Avoids strain on other parts of foot
* May be converted to Keller or implant arthroplasty if procedure fails
* Relief of pain
* Simultaneous reduction of intermetatarsal angle

## TABLE FOUR

### Disadvantages

* May promote arthritic changes at IPJ
* May aggravate pre-existing metatarsalgia if fixed in poor position
* Optimum position may be difficult to perform in some cases
* Difficulty in kneeling
* May need bone grafting
* Results in slight shortening of the hallux
* May limit style of shoe gear
* Not usually effective in active propulsion patients

## TABLE SIX

### Methods of Fixation

* Kirschner wire(s) or Steinmann pin(s)
* Staple(s)
* Cortical or cancellous screw(s)
* Mini external fixator
* Plates
* Figure-of-eight tension band wiring
* Intra osseous wire loops
* Combination

## CASE PRESENTATIONS

CASE REPORT #1

L.M. is a 56 year old white female with a chief complaint of severe pain in the plantar aspect of the left foot beneath the lesser metatarsal heads. She feels as though she is "walking on pebbles." The pain initially began four years prior and developed to the point where she could ambulate to a minimum degree. Her symptoms had significantly altered

her lifestyle. During the past year, she noticed drifting of the lesser toes, medially, and the hallux laterally. She was able to wear flat, soft shoes only. Conservative care failed to resolve her symptoms and she desired surgical correction.

Her past medical history was remarkable for a 10 year history of rheumatoid arthritis and migraine headaches. Medications included Naprosyn, Prednisone, Imuran, and Methotrexate for control of her rheumatoid arthritis in addition to Wigraine, Endep, and Carafate. Previous surgeries included an implant arthroplasty of multiple joints of both hands in 1983 as well as a previous appendectomy and hysterectomy. These were all performed without complications. The remainder of her history and physical were unremarkable.

Lower extremity examination revealed multiple plantar discrete nodular lesions of the hallux, lesser metatarsal area and heel, which were quite tender to palpation. Diffuse tylomas were also present beneath the lesser metatarsals. Some atrophy of the skin was present and consistent with her 10 year history of rheumatoid arthritis. The neurovascular status was normal. Significant orthopedic findings included a moderate HAV with deformities and medical contractures of the lesser toes. There was significant splaying between the first and second metatarsals, which was partially reducible. Crepitus was present in several of the metatarsophalangeal and interphalangeal joints. Her gait was markedly antalgic. She essentially had a shuffling type of gait pattern with minimal propulsion. (Fig. 1)

Weight bearing x-rays were essentially consistent with the clinical findings. A hallux abducto valgus deformity with metatarsus primus varus, numerous digital subluxations, and dislocations of several metatarsophalangeal joints were readily appreciated. (Fig. 2)

**Fig. 1.** Preoperative photographs. Note the deformity of the first ray multiple digital subluxations.

The following diagnosis was that of severe forefoot deformities with multiple soft tissue masses (presumably rheumatoid nodules) secondary to longstanding rheumatoid arthritis. Surgical intervention was recommended and the patient subsequently underwent reconstructive forefoot surgery.

The surgical procedures consisted of excision of multiple rheumatoid nodules from the plantar aspect of the interphalangeal joint of the great toe, the plantar aspect of the calcaneus, and the lesser metatarsal heads performed through plantar transverse semi-elliptical incisions. A resection of the second through fifth metatarsal heads was performed through the plantar incision. Arthrodesis of the second through fourth digits were performed along with an arthroplasty of the fifth digit and Kirschner wire stabilization. A first metatarsophalangeal joint arthrodesis was also performed with single Steinmann Pin fixation. (Fig. 3)

The patient was maintained in a short leg, non-weight bearing cast for seven weeks at which time the wires and pins were removed without complication. She was then permitted to ambulate in a surgical shoe for two weeks followed by a return to normal shoe gear. Physical therapy was utilized to resolve edema and improve mobility. The patient has made a full functional recovery at six months postoperatively with no pain or residual deformities. There has been no recurrence of her original deformities. The plantar incisions healed without complications and are pliable and fine line. Surgical reconstruction of her right foot deformities is anticipated this year. (Fig. 4 & 5)

**Fig. 2.** Preoperative dorsoplantar x-ray.

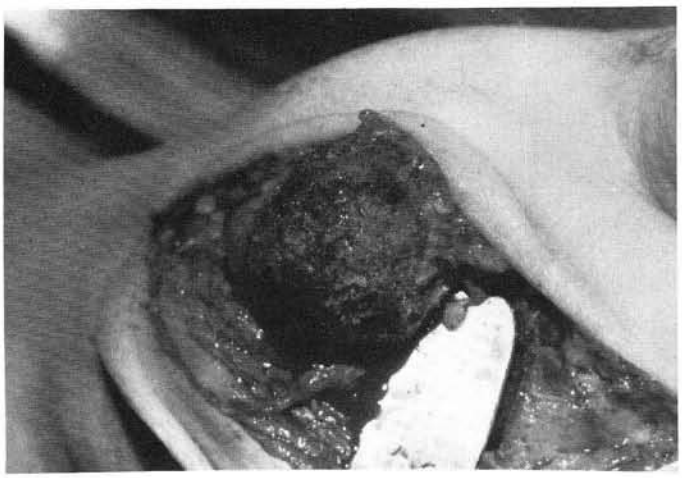

**Fig. 3.** Appearance of the first metatarsal head following removal of the articular surface and resection of the medial eminence.

**Fig. 4A.** Postoperative dorsoplantar x-ray.

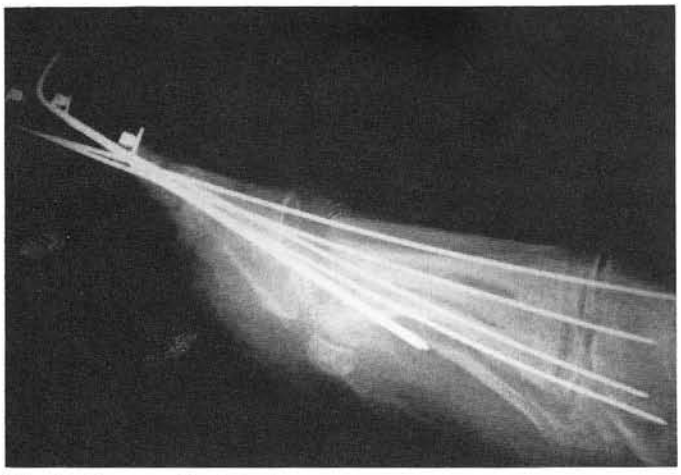

**Fig. 4B.** Postoperative lateral x-ray.

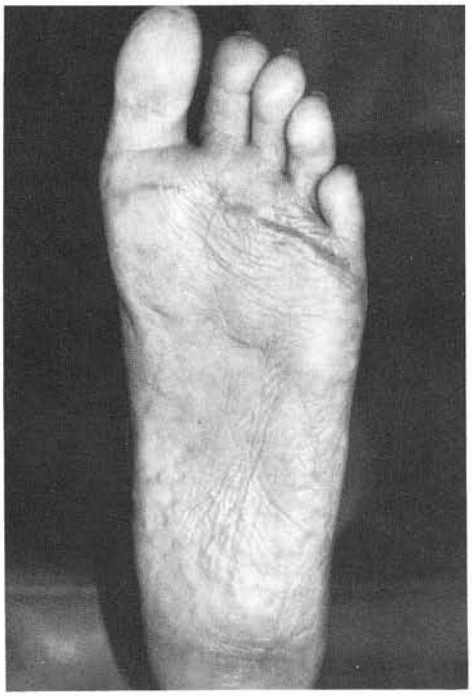

**Fig. 5A. & 5B.** Clinical presentation seven months following surgery.

**Fig. 5B.**

## CASE REPORT #2

M.P. is a 50 year old white female with a chief complaint of severe pain in the left foot with associated plantar lesions. She complains of "a protruding bone" on the bottom of her foot, preventing her from standing for any significant period of time. She has recently noticed a deviation of the second and third lesser toes in contrasting directions with increased dislocations in the sagittal plane. Conservative care failed to resolve her symptoms and she desired surgical correction.

Her past medical history was remarkable for rheumatoid arthritis of 12 years duration. Her medications included Prednisone, Methotrexate, Trilisate, and Estrogen supplements. Previous surgery included a bunionectomy of the left

foot with an arthroplasty of the fifth digit. The precise procedures were unknown. She reported allergies to penicillin, adhesive tape, codeine, and several foods. She has been totally disabled since 1985 due to her foot deformity and rheumatoid arthritis. The remainder of her history and examination was unremarkable and non-contributory.

Lower extremity examination revealed gross prominence of the lesser metatarsal heads plantarly with severe atrophy and anterior displacement of the plantar fat pad. Multiple discrete cutaneous nodules were easily identified in close proximity to the lesser metatarsal heads on the plantar aspect of the foot. Post surgical scars were noted over the first and fifth rays from prior surgery. Both digital deformities were present with the most obvious being a splaying between the second and third digits as well as apparent dorsal dislocations. The digital deformities were only partially reducible in nature. A significant limitation of hallux dorsiflexion was noted with crepitus in the joint. The neurovascular status was normal. Gait was markedly antalgic with an increase in the digital deformities noted in weight bearing. She was unable to ambulate for any significant distance barefoot due to the pain. The rearfoot alignment was satisfactory (Fig. 6A, B).

**Fig. 6A & 6B.** Clinical appearance of the foot intraoperatively prior to lengthening of the EHL tendon and fusion of the first MPJ.

**Fig. 6B.**

The final diagnosis was that of severe forefoot deformities with multiple soft tissue masses (presumably rheumatoid nodules) secondary to long standing rheumatoid arthritis. Surgical intervention was recommended and the patient subsequently underwent reconstructive forefoot surgery.

The same surgical approach described in Case #1 was performed without significant variations. Multiple rheumatoid nodules were excised along with resection of the lesser metatarsal heads through two transverse semi-elliptical plantar incisions. The lesser digits were stabilized with Kirschner wires and fusion of the first metatarsophalangeal joint accomplished with a single Steinmann pin.

Her postoperative course was unremarkable and she underwent a full functional recovery without complications. She was managed in a similar manner as previously described. To date, there has been no residual deformity or recurrence of the preoperative deformities and she has a solid fusion of the first metatarsophalangeal joint (Fig. 7A, B).

## DISCUSSION

Although several alternatives are available for reconstruction of the first metatarsophalangeal joint in the rheumatoid foot (e.g. Keller procedure, total implant arthroplasty, metatarsal head resection) the authors selected arthrodesis as the procedure of choice to provide stability to the medial column and toes, correct the deformity, and to provide an acceptable cosmetic result. Although implant arthroplasty would certainly provide a range of motion for the metatarsophalangeal joint which is not obtained by arthrodesis, it offers no significant advantages in patients whose gait pattern is essentially apropulsive, deliberate, and of a shifting nature. The dynamic and propulsive foot would certainly benefit more from the use of a total implant arthroplasty. This was not the situation in these two case reports. Furthermore, a closing abductory base wedge osteotomy would have been necessary to reduce the intermetatarsal angle in Case #1 to prevent the probability and likelihood of excessive stresses on the implant itself. While excessive stress on the implant can sometimes be prevented by the aggressive resection of bone from both the first metatarsal head and proximal phalangeal base, it often leaves one with a distorted metatarsal parabola. In such cases usually the second metatarsal is the apex of the parabola. It is the authors' feeling that in the rheumatoid foot, it is not necessary to have a normal metatarsal parabola and that a normal linear one from the first through fifth metatarsal will provide excellent function.

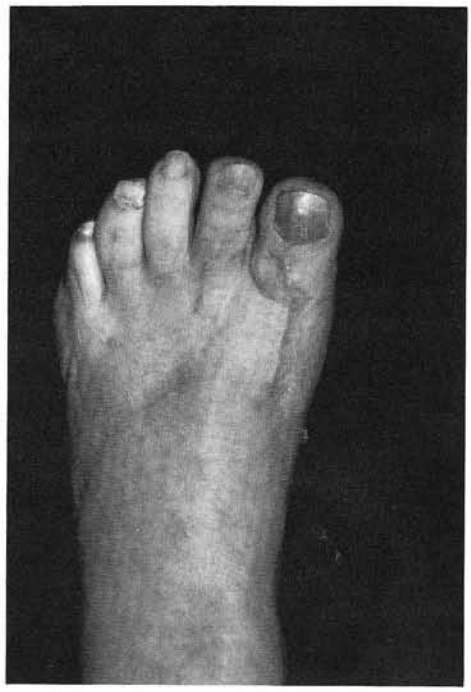

**Fig. 7A. & 7B.** Clinical appearance four months postoperatively. Plantar lesions resolved without the need for metatarsal osteotomies.

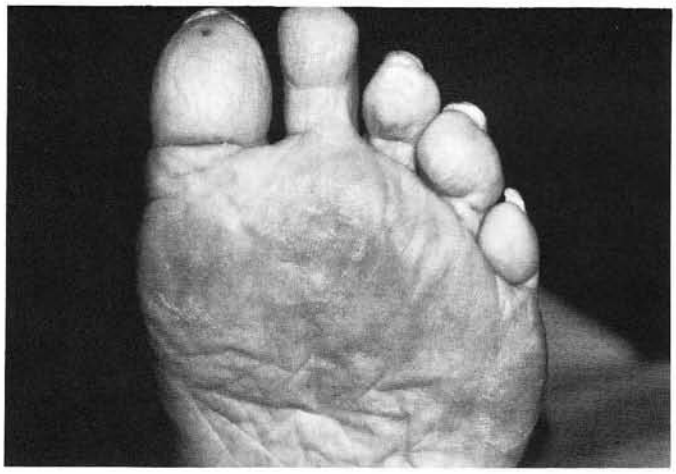

**Fig. 7B.**

Although a joint resection procedure (i.e: Keller bunionectomy) was also a viable option, the authors' felt that first metatarsophalangeal joint arthrodesis offered greater stability to the medial column of the foot and hallux. The stability to the hallux would assist in the maintenance of the lesser digital correction and long term alignment.

Finally, fusion is least likely to result in recurrence, overcorrection or future sagittal plane dislocation. Because a panmetatarsal head resection was performed, it was necessary to take additional bone from the first metatarsal head and less from the proximal phalanx to provide an acceptable metatarsal breakpoint. Restoration of a normal parabola was not of paramount importance in these two patients as their gait cycle was totally apropulsive in nature. Careful planning and positioning of the hallux on the first metatarsal head, however, appears to be an important component of the surgery to ensure good function and the ability to wear normal shoegear postoperatively. Cosmetically, it is very pleasing and acceptable.

## CASE REPORT #3

A. S. is a 74 year old white female who presented with a chief complaint of an unsightly great toe as well as the inability to wear normal shoegear because of its position. She also complained of severe callouses on the plantar aspect of the foot requiring routine palliative care as well as pain in the lesser toes due to deformity. She had noticed progressive dorsal migration of the great toe since a revisional bunion surgery was performed 11 years ago. She had previously undergone a bunionectomy. She has made modifications to her own shoes to accommodate the great toe. Conservative treatment has consisted of routine care as well as splinting of the great toe without success.

Her past medical history was unremarkable and she was in excellent overall health. Previous surgeries included a hysterectomy and mastectomy without complication. She denied taking any medications or allergies. She described herself as an energetic homemaker and active grandparent.

Lower extremity examination revealed severe tylomas beneath the first, second, and fifth metatarsals of the left foot. Dorsal clavi were noted on several of the lesser digits and a severe hammertoe contracture of the second digit was present with dislocation at the metatarsophalangeal joint level. The hallux was dorsiflexed 90-100 degrees on the first metatarsal at the MPJ level. No contractures were present at the interphalangeal joint level of the great toe. Muscle testing revealed a complete loss of plantarflexory power of the great toe of the left foot. There was no evidence of an ability to actively contract the flexor hallucis longus or the flexor hallucis brevis muscles. The extensor tendon was extremely contracted and taut and the toe could not be reduced to its normal position. Postoperative scars from prior surgical intervention were noted.

In relaxed stance, the great toe was dorsiflexed approximately 90 degrees from the weight bearing surface. Again, there was no ability to actively mobilize the toe in a plantar direction.

The diagnostic impression was a severe iatrogenic elevatus of the great toe with a complete loss of plantar intrinsic and extrinsic musculature to the toe from prior surgical intervention. Secondary diagnoses included hammertoe contractures of the second digit with MPJ subluxation and multiple digital contractures of remaining lesser toes.

Subsequent surgical reconstruction was performed and consisted of an open extensor hallucis longus "Z" plasty lengthening with arthrodesis of the first metatarsophalangeal joint. An arthrodesis of the interphalangeal joint of the second toe with complete sequential reduction and release with K-wire stabilization was also performed. Correction of the lesser digits was accomplished by arthroplasty technique and percutaneous extensor tenotomies.

Her postoperative course was unremarkable and she made a full functional recovery. Plantar lesions improved significantly and she returned to normal shoegear without problems. She is able to ambulate pain-free with or without shoes. Although the great toe is cosmetically short, its appearance is markedly improved over the preoperative appearance. She is delighted with the correction from both a functional and cosmetic perspective.

## DISCUSSION

This case provides some stimulating and interesting biomechanical considerations. First metatarsophalangeal joint arthrodesis appeared to be the safest procedure to correct this deformity, preserve the ankle joint dorsiflexion role of the extensor hallucis longus tendon, prevent recurrence of the deformity, and to provide a cosmetically acceptable and pleasing result. A Jones' suspension procedure with release of the first MPJ capsule was considered, but deemed inappropriate and less predictable in its outcome. Transfer of the tendon to the first metatarsal head and neck could conceivably result in excessive dorsiflexion of the metatarsal segment itself, thereby increasing lesser metatarsalgia. It might also result in a plantarflexed or flail hallux due to the complete absence of intrinsic and extrinsic musculature.

First metatarsophalangeal joint arthrodesis would return the hallux to an acceptable position from both a cosmetic and functional standpoint, while simultaneously decreasing the retrograde force on the first metatarsal. This would result in a reduction of pressure to the metatarsal head, thereby alleviating the plantar lesion. Correction of the lesser digital deformities also decreases plantar lesions and metatarsalgia while improving upon the function of the extensor digitorum longus as an active dorsiflexor of the ankle joint.

Implant arthroplasty would not be an acceptable alternative, as it would not restore balance or function around the first metatarsophalangeal joint. This was not even considered a viable option. Furthermore, the resection of bone necessary for a total implant arthroplasty would only aggravate the metatarsalgia and possibly create additional transfer lesions.

Finally, patients should be aware of the final length of the great toe when electing to undergo arthrodesis of the first metatarsophalangeal joint. In cases where previous surgery has been performed, an excessively short hallux may result. In such cases consideration should be given to the use of an autogenous bone graft to accomplish some increase in length of the great toe. In this case, the author felt that the increased risk, complications and prolonged recovery did not warrant the potential gain. The patient agreed to this and was not concerned over the cosmetic appearance of the great toe, but rather her functional disabilities.

## SUMMARY AND CONCLUSION

Over the last three years, the authors have performed a total of nine fusions of the first metatarsophalangeal joint. One fibrous union has been encountered. No delayed unions, non-unions, or pseudoarthroses have resulted to date. In all cases, arthrodesis was accomplished by the use of a single Steinmann pin and in two cases supplemented with a small bone staple or secondary Kirschner wire to prevent rotation of the great toe.

The final position of fusion is the single most important variable in determining postoperative function. The toe should be fused in slight dorsiflexion and abduction. A primary reference utilized in surgery is the position of the lesser toes. When a transverse deviation of the lesser digits is present, the hallux is fused in a parallel position to the second toe. While initial cases were fused with slight valgus rotation based upon the recommendation in the orthopedic literature, the authors have abandoned this aspect of the procedure and have not found it to be helpful in either the cosmetic appearance or long-term function.

The authors' technique of fusion utilizing a single Steinmann pin with an occasional secondary device to prevent rotation in the frontal plane has proven quite successful. The use of miniature external fixators, cortical or cancellous bone screws, and figure-of-eight tension band wiring represent alternative methods of fixation which provide enhanced compression at the joint. The authors hope to report on this technique at a future date.

Finally, success of the procedure depends on precise surgical technique as well as a recognition of the appropriate indications. It is imperative that patients understand the anticipated final cosmetic appearance as well as the functional limitations following fusion. When the procedure has been performed for the proper indications, optimal position obtained, and the patient fully informed, excellent results can be expected.