CHAPTER 13

FIRST MPJ FUSION FOR THE HIGH INTERMETATARSAL ANGLE

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INTRODUCTION

Arthrodesis is a time-honored procedure for addressing multiple disorders of the first metatarsophalangeal joint (MPJ). Many disorders are routinely managed by first MPJ fusion.[1] (Table 1) In patients with a significantly increased intermetatarsal angle (IMA), first MPJ fusion might seemingly require concomitant metatarsal osteotomy or metatarsocuneiform arthrodesis to decrease splaying of the first metatarsal. An extensive review of the orthopedic and podiatric literature by the senior author has failed to identify articles defining the necessity of performing other procedures to reduce the intermetatarsal angle when performing a first MPJ fusion. In the authors' experience, this has rarely been necessary.

Although not a primary consideration, consistent reduction in IMA with first MPJ fusion has been observed by other authors.[2-6] (Table 2) Mann and Katcherian specifically addressed this parameter in their review of 47 fusions.[7] They demonstrated an average IMA decrease of 4.4°. When their patients were grouped or tiered by the preoperative IMA, a proportionally larger change (reduction) in IMA was seen in patients with higher preoperative angles (13-19 degrees). Patients who had undergone previous surgery of the first ray, showed a relatively smaller IMA decrease (2.7°) compared to

Table 1

Indications for First MPJArthrodesis

- Failed Bunion Procedures
- Failed Implant Arthroplasty
- Neuromuscular Disease
  - Cerebral Palsy
  - Poliomyelitis
  - CVA
- Chronic Gouty Arthritis
- Inflammatory Arthritis
  - Rheumatoid Arthritis
  - Psoriatic Arthritis
  - Charcot Neuroarthropathy
  - Infection/Septic Arthrits
- Ligamentous Laxity
  - Congenital
  - Down's Syndrome
  - Ehlers-Danlos Syndrome
  - Marfan's Syndrome
- Severe HAV
- Moderate HAV with sub 2 lesion
- HAV with Metadductus
- Failed Keller
- Loss of Flexor/Extensor Function
- Hallux Varus
  - Congenital
  - Iatrogenic
- Trauma
  - Joint Proper
  - Sesamoid Apparatus
- Hallux Limitus/Rigidus

Table 2

IMA Changes with First MPJ Arthrodesis

Authors	# of Patients	Average Pre/ Post IMA	IMA Change
Sage et al.	12	9.6 / 7.9	1.7
Wu	27	11.9 / 8.0	3.9
Humbert et al.	31	Unknown	5.7
Gregory et al.	32	16.2 / 12.0	4.2
Tourne et al.	41	15.0 / 11.0	4.0
Mann and Katcherian	47	12.7 / 8.3	4.4
Riggs and Johnson	206	12.0 / 8.0	4.0

patients undergoing fusion as a first time procedure (5.6°). They were unsuccessful in attempting to correlate the amount of IMA change based on postoperative MPJ angle (hallux abductus angle).

When planning first MPJ arthrodesis in the patient with an elevated IMA, many questions arise. Although some reduction in IMA is generally observed and perhaps even expected, is the IMA reduction predictable for a given preoperative IMA value? Is the reduction based on the decrease in the hallux abuctus/MPJ angle? Will previous surgery significantly reduce the amount of IMA correction available and if so why? Finally, when, if ever, is a proximal osteotomy or fusion indicated? The following review was undertaken to attempt to gain further insight into some of these issues.

MATERIALS AND METHODS

The authors performed a retrospective chart and x-ray review of 30 consecutive first MPJ fusions performed by the senior author between January 1995 and December 1999. To specifically evaluate changes in IMA, only patients with a preoperative diagnosis of hallux valgus (abductus) deformity and an IMA of 10° or greater were included in the study. This resulted in a total of 11 patients. One patient meeting these criteria and requiring concomitant metatarsal osteotomy will be discussed, but is not included in the analysis.

Three males and 6 females (2 bilateral) were included, ranging in age from 16 to 78 with an average age of 53 years. Three patients carried the additional diagnosis of cerebral palsy. Two patients had rheumatoid arthritis. There were 6 left and 5 right feet. Follow-up ranged from 7 to 48 months with an average of 17 months.

The surgical technique and method of joint preparation were performed as previously described by the senior author.[8] The cartilage was resected using a curettage technique in most cases; in some cases the cartilage was removed using small rongeurs and/or a power burr. In all cases, emphasis was placed on preserving the convexity of the first metatarsal head and the concavity of the proximal phalangeal base. This technique permitted ready repositioning of the joint in both the transverse and sagittal planes in the event that the initial position of fixation was determined to be undesirable. Minimal shortening resulted. It should be emphasized that the desired position of fusion in all cases was one where the hallux was parallel to the second digit with minimal dorsiflexion from the ground-supporting surface. Placement of the hallux directly in line with the long axis of the first metatarsal was not necessarily the goal.

Fixation methods included crossing screws (2 cases), crossing screws and dorsal plate fixation (3 cases) and Kirschner-wire fixation (6 cases). All patients healed uneventfully except one patient who sustained a delayed union requiring an additional period of 4 weeks non-weightbearing immobilization (Case 6).

All patients had preoperative and postoperative weightbearing anteroposterior (dorsoplantar) pedal radiographs. The preoperative IMA was determined by the angular relationship formed by the intersection of the lines representing the bisection of the first and second metatarsal shafts. The postoperative IMA was recorded in the same manner. The preoperative and postoperative hallux abductus angle (HAA) was determined by the angular relationship formed by the intersection of the lines representing the bisection of the first metatarsal and proximal phalanx shafts. All measurements were determined by the same individual (J.G.) to ensure consistency in technique and were confirmed by the senior author.

RESULTS

The preoperative IMA ranged from 10° to 25° (14.7° average). The postoperative IMA ranged from 4° to 15° (8.4° average). The change in IMA ranged from 0° to 14° (6.3° average). The preoperative HAA ranged from 21° to 70° (35.1° average). The postoperative HAA ranged from 2° to 23° (13.7° average). The change in HAA ranged from 6° to 60° (21.8° average). Individual patient measurements are shown in Table 3.

No significant relationships were identified between IMA correction and the preoperative or postoperative HAA. No trends or patterns were identified between IMA reduction and preoperative or postoperative HAA. The largest reduction in IMA was 14° (Case #3). Some IMA reduction was observed in all patients except Case #9 where the IMA of 15° remained unchanged.

One patient, having previously undergone a failed proximal metatarsal osteotomy procedure, was treated with closing base wedge osteotomy and first MPJ arthrodesis. No other cases required osteotomy or fusion proximal to the first MPJ fusion site.

DISCUSSION

The results from the current investigation support previous observations. The average IMA reduction seen in this group of selected patients (6.3°) is higher than most other reports.[2-7] This might be expected as these patients were selected having IMA measurements greater than 10°. (Fig. 1) Most other reports did not specifically address this relationship, and therefore included a majority of patients without significant transverse plane angular deformities. Our results do, however, correlate with the 6.6° IMA reduction seen in Mann and Katcherian's stratified group of patients with IMA between 13° and 19°.[2]

Others have attempted to explain the mechanism for IMA reduction. Wu felt that the restoration of horizontal vector muscle pull of the extensor hallucis longus, extensor hallucis brevis and adductor hallucis worked to reduce the metatarsus primus varus and lateral subluxation of the sesamoid complex thereby maintaining first metatarsal closeness to the second metatarsal.[3] Humbert maintained that fusion restored the adductor force of the conjoined tendon and reduced the intermetatatarsal angle; an action that seemingly increased over time.[2] Other authors have agreed with this theory in spite of any convincing studies to prove or refute the idea.

It is commonly accepted that hallux valgus and metatarsus primus varus are of either dynamic, structural or combined etiologies. As the hallux deviates laterally, with or without frontal plane rotation, the resultant vector forces (retrograde pressure) create splaying between the first and second metatarsal segments. The basis for muscle tendon rebalancing procedures about the first MPJ has been to eliminate the imbalance and return the hallux to a more normal congruous position. This eliminates the retrograde pressure of the hallux and results in a significant decrease in splaying between the first and second metatarsal segments.

Although the authors were unable to demonstrate a specific or direct relationship between any one radiographic variable and the amount of IMA correction, they agree with the belief of other authors that other concomitant procedures are rarely necessary to decrease the splaying. The decision to perform an additional procedure to reduce intermetatarsal splaying should be determined intraoperatively. Intraoperative radiographs should be taken following temporary fixation of the first MPJ to determine the amount of reduction of the intermetatarsal splaying if doubt or questions exist in the surgeon's mind. In most cases the need for an additional procedure can be determined clinically.

The role of lateral release of the intrinsic musculature and/or lateral capsulotomy is deserving of discussion. The senior author usually performs a sequential release of the lateral structures as described by Ruch. This typically consists of release of the adductor tendon from the base of the proximal phalanx as well as the fibular sesamoidal

Table 3

Radiographic Measurements

Patient		Pre IMA	Pre HAA	Post IMA	Post HAA	IMA Change	HAA Change
1	(D.F.)	15	30	13	15	2	15
2	(B.B.)	10	25	8	19	2	6
3	(E.C.)	25	30	11	3	14	27
4	(N.U.)	15	45	8	2	7	43
5a	(T.B.)	12	47	3	23	9	24
5b	(T.B.)	15	38	5	22	10	16
6	(J.K.)	12	25	8	14	4	11
7	(B.H.)	15	25	7	10	8	15
8a	(C.L.)	14	30	10	15	4	20
8b	(C.L.)	14	70	4	10	10	60
9	(C.W.)	15	21	15	18	0	3
Averages		**14.7**	**35.1**	**8.4**	**13.7**	**6.4**	**21.8**

Figure 1A. Preoperative dorsoplantar radiograph in a geriatric patient with a severely painful HAV deformity. Note dislocation of the first MTP joint and the large intermetatarsal angle as a result of the dislocation and resultant retrograde pressure of the hallux on the metatarsal head. This has resulted in significant splaying between the first and second metatarsal.

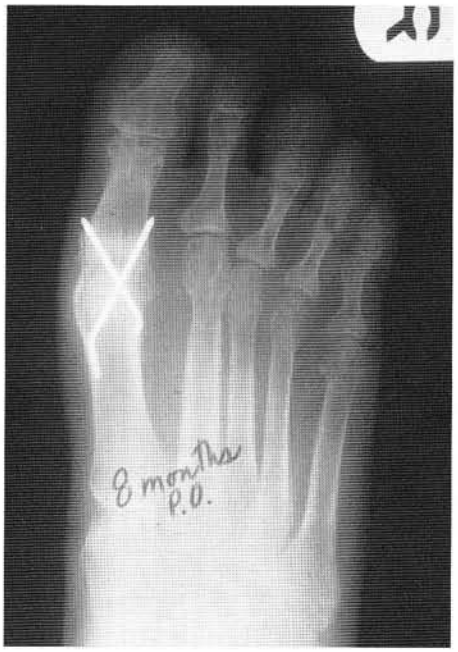

Figure 1B. Postoperative radiograph of the same patient following successful arthrodesis of the great toe. An excellent reduction of the intermetatarsal is seen. No additional procedures were performed. Slight clinical overcorrection is present; fusion of the hallux with slight abduction might have been more beneficial.

Figure 2A. Preoperative radiograph in a patient with concomitant hallux limitus deformity and a recurrent HAV deformity. Some type of osteotomy was performed in the proximal diaphysis of the first metatarsal. The splaying between the first and second metatarsal was clinically fixed and rigid in nature.

Figure 2B. Postoperative radiograph following first MTP joint arthrodesis. A closing base wedge osteotomy was necessary to reduce the splaying between the first and second metatarsals. Soft tissue release of the lateral aspect of the first MTP joint was not found to be effective intraoperatively.

ligament; in some cases the author has also excised the fibular sesamoid itself to help in the positioning of the hallux in a more congruous attitude. If no lateral release was performed, can one anticipate and expect a greater reduction of the intermetatarsal angle due to preserved or enhanced function of the adductor hallux muscle? If the insertion of this intrinsic muscle is maintained and a solid fusion of the first MPJ achieved, will the action of this muscle be to decrease the splaying between the first and metatarsal segments? Further scientific study is clearly needed. If conclusive evidence indicates that this intrinsic muscle is likely to function in this manner, then lateral release should be avoided whenever possible.

The one case requiring metatarsal osteotomy is unique in that a previous basilar osteotomy had left an iatrogenic medial bowing/splaying of the first metatarsal shaft. This in effect created a true structural deformity rather than a positional one and therefore required an ancillary procedure to effectively decrease the intermetatarsal angle. (Fig. 2) The patient's opposite foot did not require a similar procedure. (Fig. 3)

The only case where no IMA reduction was observed involved an adolescent who had previously undergone two separate bunion procedures. Previous surgery, whether causing iatrogenic angular deformities, or simply interfering with the dynamic realignment of musculotendinous forces about the first MPJ, can predictably necessitate consideration for performing concomitant metatarsal osteotomy. The final decision is one that must ultimately be made at the time of surgery.

CONCLUSION

Arthrodesis is commonly used for angular deformities about the first MPJ. In patients with an increased IMA, fusion is likely to reduce this to near normal values. Patients having undergone previous procedures about the first ray segment may require metatarsal osteotomy to allow acceptable reduction of the IMA. At this point, no predictable

Figure 3A. Preoperative dorsoplantar radiographs of the left foot of the same patient shown in Figure 2. Intra-operatively, significant degenerative joint disease was observed correlating clinically with the limited and painful range of motion of the great toe. First MTP joint resulted in complete resolution of all symptoms. Note the excellent reduction of the intermetatarsal angle to normal. The patient noted a significant decrease in the width of the forefoot. He returned to his full level of activities as a construction supervisor.

Figure 3B. Postoperative radiograph.

amount of IMA reduction can be predicted based on preoperative or postoperative angular measurements alone. (Fig. 4) The final decision must be made intraoperatively based on clinical observation and radiographs. The authors' experience is consistent with that published to date by the orthopedic community.

Figure 4A. Preoperative dorsoplantar radiograph in 63 year-old male with a severe HAV deformity with concomitant residual metatarsus adductus and multiple lesser hammertoes with MPJ dislocation/subluxation.

Figure 4B. Initial postoperative radiograph demonstrating good alignment of the hallux via arthrodesis of the first MTP joint. Although non-weightbearing, the radiograph suggests satisfactory reduction of the intermetatarsal angle.

Figure 4C. Follow-up radiograph 8 months later revealed a persistent metatarsus primus varus deformity, which was completely asymptomatic. The true intermetatarsal angle was much larger than the measured IMA on x-ray. Follow-up complaints were related to the second MTP joint dislocation. Although less than ideal from a cosmetic standpoint, the patient did not desire further surgery to correct for the metatarsus primus varus; this could be easily reduced by a proximal base wedge osteotomy or arthrodesis of the first metatarsocuneiform joint. The first MTP joint fusion site would not require take down.

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