INDICATION SPECIFIC PLATE FIXATION FOR PROXIMAL 1st METATARSAL OSTEOTOMIES

American Orthopaedic Foot & Ankle Society's

20th Anniversary Summer Meeting
July 29-31, 2004
Seattle, WA

William T. McPeake, M.D.
Knoxville Orthopedic Clinic
Knoxville, TN

OBJECTIVE

The predictability of indication specific plate fixation for proximal first metatarsal osteotomies was determined by observing change in length and alignment (anterior/posterior and lateral planes) of the first metatarsal as well as noting pertinent clinical data.

METHOD

A series of 81 proximal osteotomies of the first metatarsals were fixed with a dorsally placed indication specific plate. All were performed in conjunction with a first metatarsophalangeal joint moderate hallux valgus correction (average MPJ angle 31.6 degrees). These are examined by observing preoperative and post healing x-rays for first metatarsal shortening, first metatarsal head elevation, and permanency of anterior/posterior alignment of the osteotomy. Statistical analysis used Chi-square and unpaired Student's t test. Statistical significance was considered at a value of $p < 0.05$.

Indication Specific Proximal First Metatarsal Osteotomy Plates from Acumed

TECHNIQUE

With regional or general anesthesia, all of the first metatarsal osteotomies were performed with a Stryker oscillating crescentic saw approximately 1.5 centimeter distal to the first metatarsocuneiform joint. The radius of the osteotomy is directed proximally. The osteotomy is made at an angle, which bisects the perpendicular of the metatarsal shaft and perpendicular to the plantar surface of the foot.7 The periosteum is carefully elevated at the osteotomy site and care is taken to prevent overheating the bone with irrigation. The osteotomy is performed after removal of the medial eminence of the first metatarsal head but before capsular repair of the bunion procedure.

Tentative reduction and fixation is obtained with a Kershner wire. The osteotomy is then fixed with a dorsally placed indication specific plate and screws.(Acumed) Two proximal and two distal screws are used. Care is taken not to impinge the first metatarsocuneiform joint. The holes for the distal two screws must be tapped to prevent cracking of the more cortical bone of the metatarsal shaft. Morselized bone from the excised medial eminence of the first metatarsal head is then placed about the osteotomy site as a bone graft. The wound is closed after observing the osteotomy and fixation with fluoroscopy.

Preoperative and postoperative standing x-rays were examined for anterior/posterior first metatarsophalangeal joint angle (MPJ angle); anterior/posterior first metatarsal, second metatarsal angle (IM angle); anterior/posterior lengths of the first and second metatarsals; anterior/posterior first metatarsal base shaft angle (MBS angle); and a lateral first metatarsal head height (1st MHH) (Figure 1 and Figure 2). The lateral standing x-ray is obtained by directing the beam 15 degrees toward the calcaneus. This alignment yields a better projection of the base line of the first metatarsal.

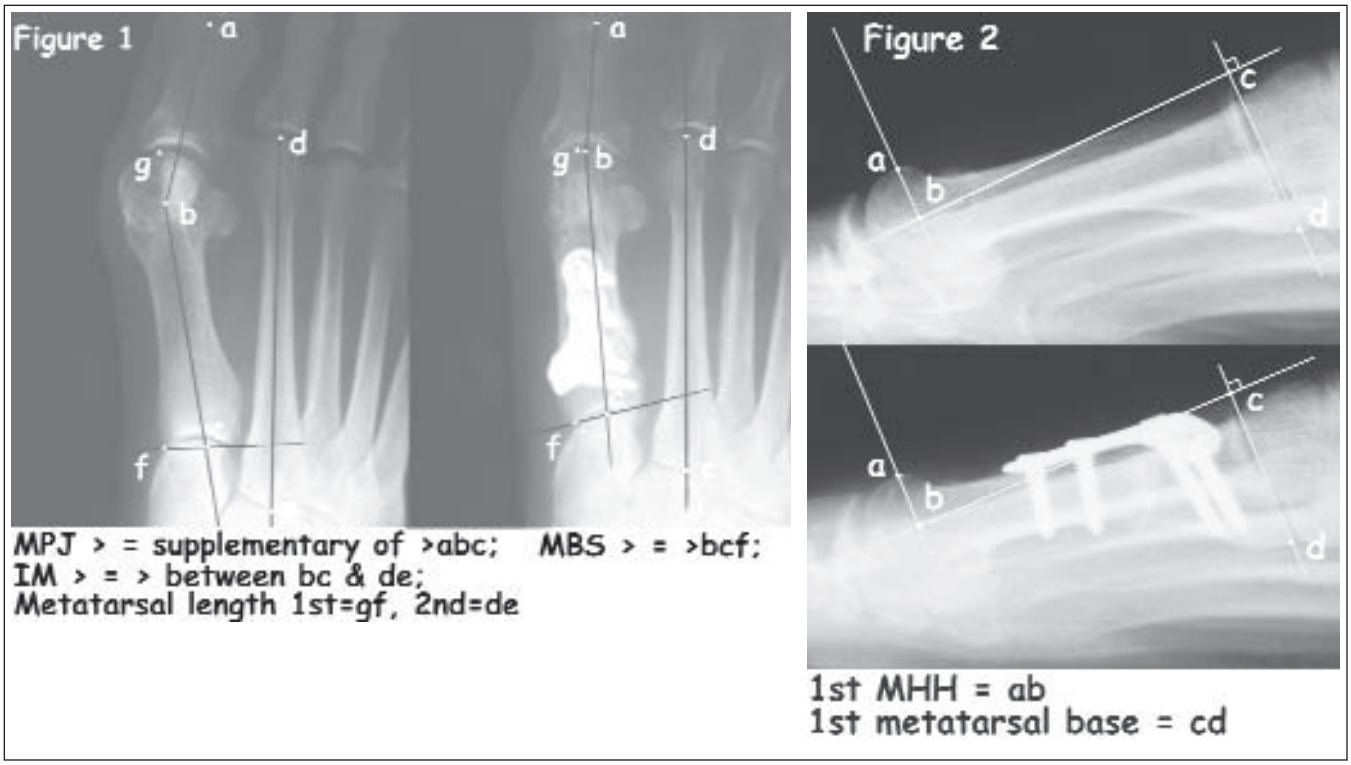


TABLE I

	Mean Pre Op	Mean Post Op	Mean Correction	P value *
MPJ Angle	31.6°	10.4°	20.9°	1.475 E-30
IM Angle	13.6°	4.7°	9.0°	2.682 E-34
MBS Angle	94°	78°	15.8°	3.462 E-34
1st Met Length	6.5 cm **	6.6 cm	-0.1 cm	0.394
1st Met HH	4.47 mm	4.01 mm	-0.46 mm (down)	0.274

* Student t test
** Calculated value

RESULT

Of the 81 osteotomies performed, there were no infections and no encroachments on the first metatarsocuneiform joint. Four patients (5%) have requested hardware removal secondary to persistent tenderness of the overlying soft tissue. All osteotomies healed with only one delayed union. The delayed union was associated with x-ray signs of screw loosening and eight millimeters of distal first metatarsal head elevation (Figure 3). The delayed union osteotomy was placed more distally. The dense cortical bone at this level is slower to heal and might have resulted in the delayed union. There were no broken screws or plates.

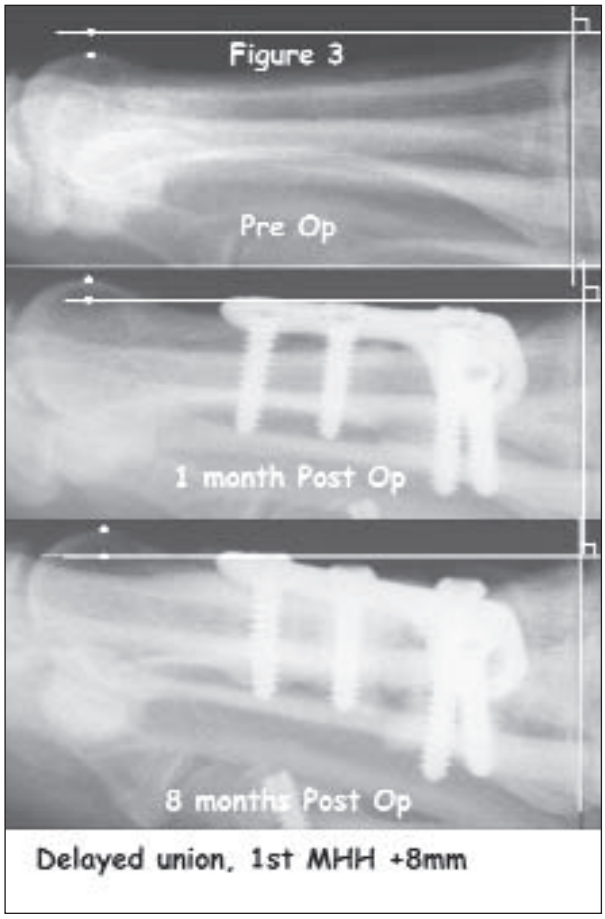
The mean preoperative IM angle was 13.6 degrees. Following correction there were five incidents of negative IM angle. Excluding these five, the mean postoperative IM angle was 4.7 degrees (range 0 to 12). The average correction of the IM angle was 9.0 degrees.

The mean preoperative MPJ angle was 31.6 degrees. Following correction there were six incidents of varus alignment. Two of these varus deformities were severe, thirty-two and twenty-five degrees respectively. The first was salvaged with an arthrodesis and the same has been recommended for the second. Three of the varus deformities were associated with a postoperative negative IM angle. Excluding the six incidents of varus alignment, the mean postoperative MPJ angle was 10.4 degrees (range 0 to 23). The average correction of the MPJ angle was 20.9 degrees.

The mean preoperative first MBS angle was 94 degrees. The mean postoperative first MBS angle was 78 degrees. The average correction of the MBS angle was 15.8 degrees. The average correction of the MBS angle was significantly greater than the average correction of the IM angle (Chi-square p = 8.023 E-07). The difference in the amount of correction is related to the first metatarsal-cuneiform joint elasticity.

The preoperative and postoperative first metatarsal length was measured. There was a significant difference in length of the two groups (t test, p = 0.00164).

In order to account for different x-ray techniques, the preoperative and postoperative second metatarsal lengths were used to establish a ratio. "The third or fourth metatarsal length was used when second metatarsal procedures were performed". This ratio was used to calculate the expected preoperative first metatarsal length.3 The calculated value was then compared with the measured postoperative first metatarsal length. There was no significant difference found in the measured postoperative and calculated preoperative length of the first metatarsal (t test, p = 0.394).



There was one delayed union which resulted in an eight millimeter elevation of the first metatarsal head height. Excluding this delayed union as an outlier, the mean postoperative 1st MHH change was a -.46 millimeters "slightly lower". There was no significant difference in the preoperative and the postoperative first metatarsal head height (t test p = 0.274).

The individual with the delayed union developed metatarsalgia with the second metatarsal head and later required a second metatarsal osteotomy.

DISCUSSION

There are many described methods of osteotomies of the first metatarsal used in conjunction with repair of hallux valgus deformities.[1,3-10,12] Likewise there are various means reported to stabilize these osteotomies. The basilar crescentic osteotomy has been a reliable choice for correcting moderate to severe hallux valgus deformities and one that the author has relied on for over twenty years. Osteotomy fixation has evolved over time, going from Steinmann pins to various types of screws. [7,9,11-14]

Both maintaining first metatarsal length and preventing a dorsal elevation malunion of the first metatarsal head are important to avoid metatarsalgia of second metatarsal transfer lesions.[2,3,5,9,10,13-15] Therefore the reliability and predictability of the method of fixation is of significant importance.

Although there have been many clinical studies to show the effectiveness of using the basilar crescentic first metatarsal osteotomy,[1,4,7-9,11,13,14] none have focused on intrinsic parameters of the first metatarsal alignment to show the reliability of the osteotomy fixation. The purpose of this study was to observe postoperative x-ray measurements that are directly related to the fixation of the basilar first metatarsal osteotomy. Anterior/posterior and lateral alignment was examined with x-ray measurements only related to the first metatarsal, MBS angle and 1st MHH respectively. It is believed that these measurements are more accurate in determining reliability of the fixation device because the variance allowed by adjacent joint flexibility is excluded.

The variance of length of the first metatarsal following osteotomy was also observed and found to be negligible.[4,5] The only three-dimensional characteristic excluded from this study was axial rotation. Because of the nature of the crescentic osteotomy, axial rotation would be difficult to achieve even if desired.

The six incidents of postoperative hallux varus were disturbing and were related to three incidents of over correction of the IM angle. As expected, the negative IM angle was related to a greater then average change in the first MBS angle.

The retained hardware has been well tolerated. Although the patients are advised preoperatively that the plate and screws may yield postoperative discomfort requiring removal, only four have been removed to date. These four individuals obtained relief of their discomfort with hardware removal.

CONCLUSION

This study of intrinsic first metatarsal radiographic measurements yielded predictable results using indication specific plate fixation for proximal first metatarsal osteotomies. The plate fixation offers an easy and straightforward means of stabilizing crescentic basilar osteotomies of the first metatarsal used in conjunction with moderate bunion deformities.

REFERENCES

1. Dreeben, S., Mann, R.: Advanced Hallux Valgus Deformity Long Term Results Utilizing the Distal Soft Tissue Procedure and Proximal Metatarsal Osteotomy. Foot and Ankle International 17(3) 142, 1996.

2. Easley, M., Kiebzak, G., Davis, H., Anderson, R.: Prospective Randomized Comparison of Proximal Crescentic and Proximal Chevron Osteotomies for Correction of Hallux Valgus Deformity. Foot and Ankle International 17(6) 307, 1996.

3. Grace, D., Hughes, J., Klenerman, L., A Comparison of Wilson and Hahmann Osteotomies in the treatment of Hallux Valgus. JBJS. 70B (2): 236-241, 1988.

4. Jahss, M. H., Troy, A. I., Kummer, F., Roentgenographic and Mathematical Analysis of First Metatarsal Osteotomies for Metatarsus Primus Varus: a comparative study. Foot and Ankle International 5:280-321, 1985.

5. Kammer, F., Mathematical Analysis of First Metatarsal Osteotomies. Foot and Ankle International 9(6) 218, 1989.

6. Limbird, T., DaSilva, R., Green, N., Osteotomy of the First Metatarsal Base for Metatarsal Primus Varus, Foot and Ankle International 9(4) 158, 1989.

7. Mann, R., Coughlin, M.: Hallux Valgus and Complications of Hallux Valgus. Surgery of the Foot and Ankle. 6th Edition, 1993, pp 167-294.

8. Mann, R., Distal Soft Tissue Procedure and Proximal Metatarsal Osteotomy for Correction of Hallux Valgus Deformity. Orthopedics 13(9):1013, 1990.

9. Mann, R., Radicel, S., Graves, S.: Repair of Hallux Valgus with a Distal Soft Tissue Procedure and Proximal Metatarsal Osteotomy. A long term follow-up. JBJS 74A:124-129, 1992.

10. Resch, S., Steastrom, A., Egund, N., Proximal Closing Wedge Osteotomy and Adduction Tenotomy for Treatment of Hallux Valgus. Foot and Ankle International 9(6) 272, 1989.

11. Richardson, E. G.: The Foot in Adolescents and Adults in Campbell's Operative Orthopedics, 7th Edition, Crenshaw, A., (ed.), St. Louis, C. V. Mosby, 1987, pp 829-988.

12. Sammarco, G. J., Brainard, B. J., Sammarco, V. J., Bunion Correction Using Proximal Chevron Osteotomy, Foot and Ankle International 14, (1):8, 1993.

13. Thordarson, D., Leventen, E.; Hallux Valgus Correction with Proximal Metatarsal Osteotomy: Two-year Follow-up. Foot and Ankle International 13(6) 321, 1997.

14. Veri, J., Pirani, S., Claridge, R.; Crescentic Proximal Metatarsal Osteotomy for Moderate to Severe Hallux Valgus: A Mean 12.2 Year Follow-up Study, Foot and Ankle International 22(10) 817, 2001.

15. Wanlvenhaus, A., Feldner-Basetin, H.; Basal Osteotomy of the First Metatarsal for the Correction of Metatarsus Primus Varus Associated with Hallux Valgus. Foot and Ankle International 8(6): 337, 1988.

NOTES