# Analysis of Nonunion Rate After Minimally Invasive (MIS) Metatarsal Osteotomies

Nicholas Veale, Gloria Shoshana Coden, Evan Andrew Glass, Andrzej Brzezinski, Kurt J Hofmann

INTRODUCTION: Despite the surge in minimally invasive surgery (MIS) utilization in recent years, there is minimal literature surrounding MIS outcomes of metatarsal osteotomies. We sought to assess the change in radiographic metatarsal alignment and metatarsal osteotomy union rates following MIS hallux valgus (HV) repair and lesser metatarsal osteotomy correction.

METHODS:

79 feet in 74 patients who underwent MIS HV repair and/or lesser metatarsal osteotomies between 10/1/2020 and 12/31/2022 at a single institution were retrospectively identified. A fellowship-trained foot and ankle surgeon retrospectively reviewed pre- and postoperative weight-bearing radiographs to evaluate osteotomy union rates and measure first metatarsal alignment using the hallux valgus angle (HVA), intermetatarsal angle (IMA), and distal metatarsal articular angle (DMAA). Postoperative percent (%) translation of the 1st metatarsal, union rates of the 1st metatarsal, 2nd metatarsal, 3rd metatarsal, and Akin osteotomies, and time to union were also evaluated. Mean age of patients was 58.5 years (range=19.0-79.2) and 88.6% of feet were female. Mean body mass index was 27.3 kilograms per meter$^2$ (19.5-43.8 kilograms per meter$^2$). Mean follow-up was 6.9 months (range=1.4-24 months).

RESULTS:

At most recent follow-up 83.1% of patients achieved union with the 1st metatarsal (n=54), 100% achieved union of the Akin osteotomy (n=65), 61.5% achieved union with the 2nd metatarsal (n=39), and 83.3% achieved union with the 3rd metatarsal (n=20). Mean time to union was 17.0 weeks (range=12-79 weeks) for the 1st metatarsal, 10.3 weeks (range=6-18 weeks) for the Akin osteotomy, 19.5 weeks (range=6-69 weeks) for the 2nd metatarsal, and 21.5 weeks (range=6-86 weeks) for the 3rd metatarsal. Mean HVA improved from 31.6° (range= 13.1°-55.0°) preoperatively to 9.8° (range= 1.0°-29.2°) postoperatively ($p<0.001$). Similarly, the mean IMA preoperatively was 13.5° (range=6.0°-22.0°) and decreased to 6.5° (range=1.0°-13.1°) postoperatively ($p<0.001$). Mean DMAA also decreased from 10.5° (range=1.0°-32.0°) to 5.7° (range=0.0°-24.0°) postoperatively ($p<0.001$).

DISCUSSION AND CONCLUSION:

MIS HV repair and lesser metatarsal osteotomies are an effective procedure that significantly improve a patient's HVA, IMA, and DMAA compared to preoperative measurements. Union rates were high, with 83.1% 1st metatarsal osteotomies, 100% Akin osteotomies, 61.5% of 2nd metatarsal osteotomies, and 83.3% of the 3rd metatarsal osteotomies achieving union by most recent follow-up. Union rates were fastest for the Akin osteotomy and 1st metatarsal, while the 2nd and 3rd metatarsals tended to require longer to form a radiographic union. To gain a more comprehensive understanding of these outcomes, it is important to conduct future investigations with longer term follow-up.

Table I: Radiographic Measurements

| Outcome Metric | Preoperative | Postoperative | P Value |
|---|---|---|---|
| Hallux Valgus Angle | 31.60 (13.1 -55.0) | 9.77 (1.0 - 29.2) | **< 0.001*** |
| Intermetatarsal Angle | 13.53 (6.0 - 22.0) | 6.46 (1.0 - 13.1) | **< 0.001*** |
| Distal Metatarsal Articular Angle | 10.48 (1.0 -32.0) | 5.71 (0.0 - 24.0) | **< 0.001*** |

* Statistical significance with alpha risk of 0.05; x (y - z) represents mean and range