

Comparison of Radiographic Measurements Before & After Triplane Tarsometatarsal Arthrodesis for Hallux Valgus

¹Paul Dayton, DPM, MS, FACFAS, ²Stefany Carvalho, BS, ³Rachel Egdorf, BS, ⁴Mindi Dayton, DPM, MHA, FACFAS

^{1,4}Foot and Ankle Center of Iowa, Midwest Bunion Center, Ankeny, Iowa, ²Podiatric Medical Student, Des Moines University, Des Moines, IA, ³Resident, AMITA Health St. Joseph Hospital, Chicago, IL

Literature Review

- Hallux abducto valgus (HAV) is a common structural deformity having major impact on daily activities and quality of life
- ~350,000 bunion operations yearly in the USA
- Complication rates up to 73%¹
- 100+ documented procedures-no standard protocol for selecting the most advantageous procedure
- Previous interventions focused on the transverse and sagittal planes
 - Frontal plane rotation unaddressed and therefore malaligned²
- Dual measurements to assess pre- and postoperative radiographs introduce bias³
- Lack of consistency and incorrect procedure selection based on 2D osteotomy leads to high recurrence rates and unpredictability

Purpose

Objectives include comparing preoperative and final post-operative first ray measurements: intermetatarsal angle (IMA), hallux valgus angle (HVA), tibial sesamoid position (TSP), metatarsal rotation angle (MRA) and distal metatarsal articular angle (DMAA). Quantifying rate of radiographic recurrence in patients who received triplane tarsometatarsal correction

Level 4 Therapeutic

Inclusion Criteria	Exclusion Criteria
<ul style="list-style-type: none"> Closed physal plates at time of procedure IMA between 10.0° - 25.0° HVA between 15.0° - 40.0° Acceptable surgical candidate, including use of general anesthesia Adequate pre- and post-operative radiographs available 	<ul style="list-style-type: none"> Previous HVA surgery on operative side Moderate or severe osteoarthritis at MTP joint Lack of follow up radiograph >12 months post-operative

Table 1. Inclusion and Exclusion Criteria

Methods

- Radiographic records of 108 patients (13-61 years old) (109 feet) whom underwent triplane TMT arthrodesis for symptomatic HVA
- Inclusion and Exclusion Criteria in Table 1
- HVA, IMA, TSP, MRA and DMAA measured using anatomic axis preoperatively and at final follow up (12+ months)⁴.
- Descriptive statistics used to evaluate baseline characteristics and outcome measures. Means with 95% confidence intervals (CI) reported for continuous variables.
- Secondary endpoints were presence of recurrence and rate of successful union:
 - Recurrence= IMA $\geq 12^\circ$, HVA $\geq 20^\circ$ or TSP ≥ 4 .
 - Union= progressive increase in radiodensity at arthrodesis interface, absence of hardware loosening/failure and maintenance of position

Surgical Procedure

- Lateral sesamoid ligament release was performed when lateral ankylosis was noted.
 - Lateral capsule and sesamoid ligament were only structures released
 - No further soft tissue releases carried out (no release or dissection of the dorsal capsule, no tendon releases or transfers, no capsular plication)
- Incision for tarsal-metatarsal fusion placed dorsal directly over the joint
- Two smooth 2mm pins were placed in the sagittal plane, parallel to each other, one in the metatarsal base and one in the cuneiform
 - Used as reference to visualize the frontal plane rotation
- Joint surfaces resected, including cartilage and all subchondral bone
 - Cuts oriented to correct the transverse and sagittal components
 - First metatarsal cut perpendicular to the long axis of the metatarsal
 - Cuneiform cut without disruption of the distal medial portion
 - Allowed IMA reduction without sacrificing length of the first ray
- Frontal plane rotation addressed by rotating the metatarsal in a varus direction until congruous alignment of the first MPJ and sesamoids observed clinically and radiographically
- Segments temporarily stabilized with wires
- Final fixation consisted of two small flexible locking plates with all locking screws
- Fusion site positioned with dorsal and medial cortices flush in all cases
- No sliding offset was performed in any plane
 - All correction in sagittal and transverse planes was angular

Discussion

- When reporting recurrence, common radiographic reporting bias (dual measurements to assess IMA, HVA and TSP) must be recognized
- We applied anatomic axis measurements to illustrate the improvement in radiographic measurements and true anatomic alignment of triplane TMT correction^{5,6}
- Relevance of DMAA questioned due to poor agreement in reduction of DMAA following proximal metatarsal procedures.⁷ DMAA is a 2D observation of a 3D deformity, therefore it is a radiographic artifact as we observed significant angle reduction without distal osteotomy or other joint manipulation
- Limitations:
 - Subjectivity in the evaluation of radiographs
 - Positioning during radiographs
 - Generalizability due to elective procedure and predominating female population
 - Retrospective nature

Results

Descriptive Analysis	
Sex	Male 5 Female 103
Side	Right 60 Left 49
Follow-up time	17.4 months \pm 9.58 months

Radiographic Recurrence

- 1 patient (0.9%) showed IMA $\geq 12^\circ$, HVA $\geq 20^\circ$ and/or TSP ≥ 3 at post-operative examination

	Pre-operative	Post-operative	Significance	95% CI
IMA	13.3° \pm 2.34°	5.66° \pm 2.40°	p < 0.001	-7.7
HVA	22.8° \pm 7.53°	8.00° \pm 4.48°	p < 0.001	-14.9
TSP	4.62° \pm 1.23°	2.04° \pm 0.85°	p < 0.001	-2.6
MRA	7.8° \pm 8.0°	-4.5° \pm 6.8°	p < 0.001	-12.3
DMAA	5.3° \pm 3.8°	-14.2° \pm 8.7°	p < 0.001	-14.2

Table 2. Preoperative and final postoperative measurements. Statistically significant improvement of IMA, HVA, TSP, MRA, DMAA



Figure 1. Preoperative and final postoperative measurements after triplane tarsometatarsal correction using anatomic axis to assess IMA, HVA and TSP

Conclusion

Triplane TMT arthrodesis provided patients with robust and reliable correction with low recurrence and healing problems at 1+ year

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