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## 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%<sup>1</sup>
- 100+ documented procedures with no standard protocol for selecting the most advantageous procedure
- Surgeons have focused interventions on the transverse and sagittal planes
- Frontal plane rotation unaddressed and therefore in an abnormal position after osteotomy<sup>2</sup>
- Dual measurements to assess pre- and post-operative radiographs introduces bias<sup>3</sup>
- Lack of consistency and poor procedure selection based on two-dimensional osteotomy lends to its high recurrence rate and unpredictability

## Purpose

Objectives include comparing preoperative and final post-operative first ray measurements, including intermetatarsal angle (IMA), hallux valgus angle (HVA), tibial sesamoid position (TSP), along with the rate of radiographic recurrence in patients who received triplane tarsometatarsal correction

**Level 4 Therapeutic**

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

Table 1. Inclusion and Exclusion Criteria

## Methods

- Radiographic records of 108 patients (13-61 years old) whom underwent triplane TMT arthrodesis for symptomatic hallux valgus
- Inclusion and Exclusion Criteria in Table 1
- HVA, IMA, and TSP measured using **anatomic axis** preoperatively and at final follow up (12+ months)<sup>4</sup>.
- Paired t-test was employed to determine whether differences in pre- and postoperative measurements were statistically significant (p<0.05)
- Secondary endpoints were presence of recurrence and rate of successful union:
  - Recurrence= IMA  $\geq 12^\circ$ , HVA  $\geq 20^\circ$  or TSP  $\geq 4$ .
  - Union= progressive increase in radiodensity at arthrodesis interface, absence of hardware loosening/failure and maintenance of position

## Surgical Procedure

- Lateral sesamoid ligament release (through medial midline incision without subcutaneous separation or web space incision) 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 and parallel, one in the metatarsal base and one in the cuneiform
  - Used as reference to visualize the frontal plane rotation
- Joint surfaces were 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 perpendicular to the second ray with limited removal
  - IMA reduction without sacrificing length of the first ray
- Frontal plane rotation addressed by rotating the bone in a varus direction until congruous alignment of the first MPJ and sesamoids observed clinically and radiographically
- Segments temporarily stabilized with smooth wires
- Final fixation consisted of two small flexible locking plates, anatomic locking plate with compression screw, or single/double screw fixation
- 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



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

## Results

Descriptive Analysis	
Sex	Male 5 Female 103
Side	Right 60 Left 48
Follow-up time	17.4 months $\pm$ 9.58 months

### Radiographic Recurrence

- No patients showed IMA  $\geq 12^\circ$ , HVA  $\geq 20^\circ$  and TSP  $\geq 4$  at post-operative examination

	Pre-operative	12 months Post-operative	Significance
IMA	13.3° $\pm$ 2.34°	5.66° $\pm$ 2.40°	p < 0.001
HVA	22.8° $\pm$ 7.53°	8.00° $\pm$ 4.48°	p < 0.001
TSP	4.62° $\pm$ 1.23°	2.04° $\pm$ 0.85°	p < 0.001

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

## 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<sup>5,6</sup>
- Further studies
  - Examine long-term outcomes
  - Complications
  - Recurrence
- Limitations:
  - Subjectivity in the evaluation of radiographs
  - Positioning during radiographs
  - Generalizability due to elective procedure and predominating female population
  - Retrospective nature

## Conclusion

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

## References

- Pentikainen, I., Ojala, R., Ohtonen, P., Piippo, J., & Leppilahti, J. (2014). Preoperative radiological factors correlated to long-term recurrence of hallux valgus following distal chevron osteotomy. *Foot & Ankle International*, 35(12), 1262-1267.
- Coughlin MJ, Saltzman CL, Nunley JA. Angular measurements in the evaluation of hallux valgus deformities: a report of the ad hoc committee of the American Orthopaedic Foot & Ankle Society on angular measurements. *Foot Ankle Int*. 2002;23(1):68.
- Mizuno S, Sima Y, Yamaxaki K. Detorsion osteotomy of the first metatarsal bone in hallux valgus. *J Jpn Orthop Assoc*. 1956;30:813-819.
- Gerbert J, In *Textbook of Bunion Surgery*, edited by Gerbert J, WB Saunders, New York, 2001.
- Akpinar E, Buyuk AF, Cetinkaya E, et al. Proximal intermetatarsal divergence in distal chevron osteotomy for hallux valgus: an overlooked finding. *J Foot Ankle Surg*. 2016;55(3):504-8.
- Dayton P, *Evidence-Based Bunion Surgery: A Critical Examination of Current and Emerging Concepts and Techniques*, edited by Dayton P, Springer International Publishing, Des Moines, 2018.