

# Combined First Tarsometatarsal Joint Realignment Arthrodesis with Cheilectomy for Surgical Treatment of Mid-Stage Hallux Rigidus with Severe Metatarsal Elevatus

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## STATEMENT OF PURPOSE

- The purpose of this prospective study is to determine the viability of combined first tarsometatarsal joint realignment arthrodesis with cheilectomy in managing mid-stage hallux rigidus (HR) with severe metatarsus primus elevatus (MPE).
- Hypothesis:** Combined arthrodesis and cheilectomy has the unique ability to address intrinsic first ray deformity, medial column instability, as well as decompress the first MTP joint.

## LITERATURE REVIEW

- There is controversy within the literature about the role of MPE in HR.
  - Root cited MPE as “the most frequent cause of HR” (1).
  - Meyer utilized radiographs to evaluate 120 feet and found no significant difference in mean dorsal elevation between hallux valgus (HV), HR and control groups (2).
  - Horton utilized radiographs to evaluate 264 feet and found no significant difference in first ray elevation between HV, HR & Morton’s neuroma (3).
    - However, there was a higher amount of MPE in more advanced stages of HR
  - Roukis utilized radiographs to evaluate 275 feet and found a statistically significant greater level of elevatus in HR patients (4).
  - Bouaicha et al utilized radiographs to evaluate 295 feet and found a significantly greater amount of MPE in patients with HR (+5.2 mm) as compared to HV (+2.8 mm) and control groups (+2.6 mm) (5). They also concluded that MPE greater than 5.0 mm seemed predictive for the presence of HR.
    - Authors also developed a new method of radiographic MPE calculation (Figure 1).
- Despite the controversy in the literature there are patients who have mid-stage HR with severe, divergent MPE (Figure 2).
- Traditional surgical approaches for HR with MPE have involved aggressive cheilectomy, distal 1<sup>st</sup> metatarsal decompression osteotomies or first metatarsal base plantarflexory osteotomies (5).
  - These options are not sufficient in cases of severe MPE secondary to limited plantarflexion achieved, failure to address inherent medial column instability and they do not provide correction at the apex of the deformity.
  - Aggressive cheilectomy would require substantial bone resection, not leaving adequate surface area for subsequent first MTP joint arthrodesis in the future if necessary.

## METHODOLOGY

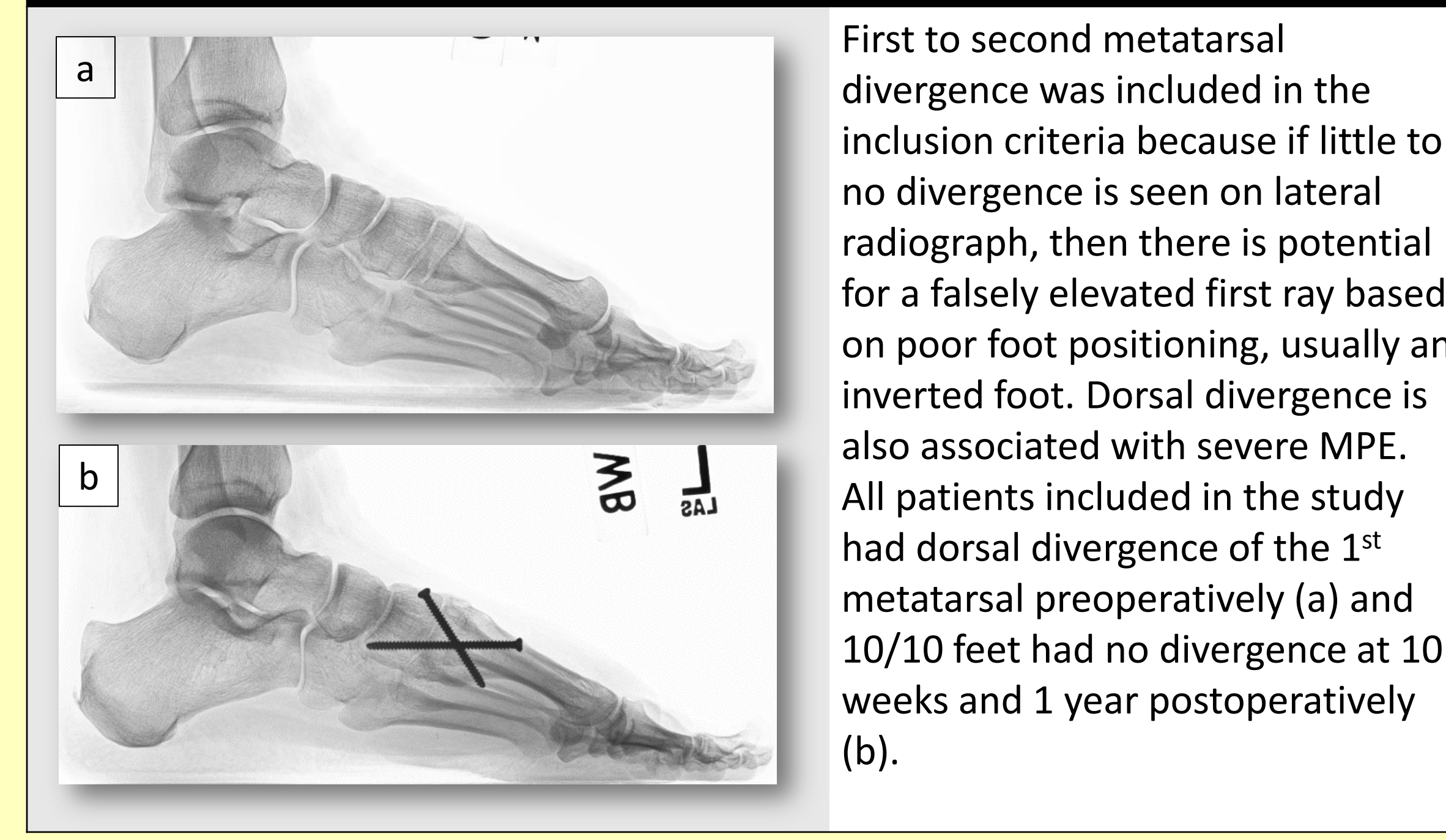
- We prospectively analyzed consecutive patients undergoing surgery for stage 2 and stage 3 HR with severe MPE from December 2013 - February 2017.
- Surgical procedures performed: 1<sup>st</sup> tarsometatarsal joint (TMTJ) realignment arthrodesis with cheilectomy
- Inclusion criteria:
  - Severe MPE, defined as  $\geq 7$  mm
  - Dorsal divergence of the 1<sup>st</sup> metatarsal in relation to the lesser metatarsals
  - Medial column instability on clinical exam
  - Stage II to early stage II HR (Drago, Oloff & Jacobs Classification) (6)
    - Lateral hallux stress dorsiflexion radiograph also utilized to further aid in determining the stage of HR preoperatively (Figure 3) (7).

**Figure 1. Radiographic Analysis of MPE**



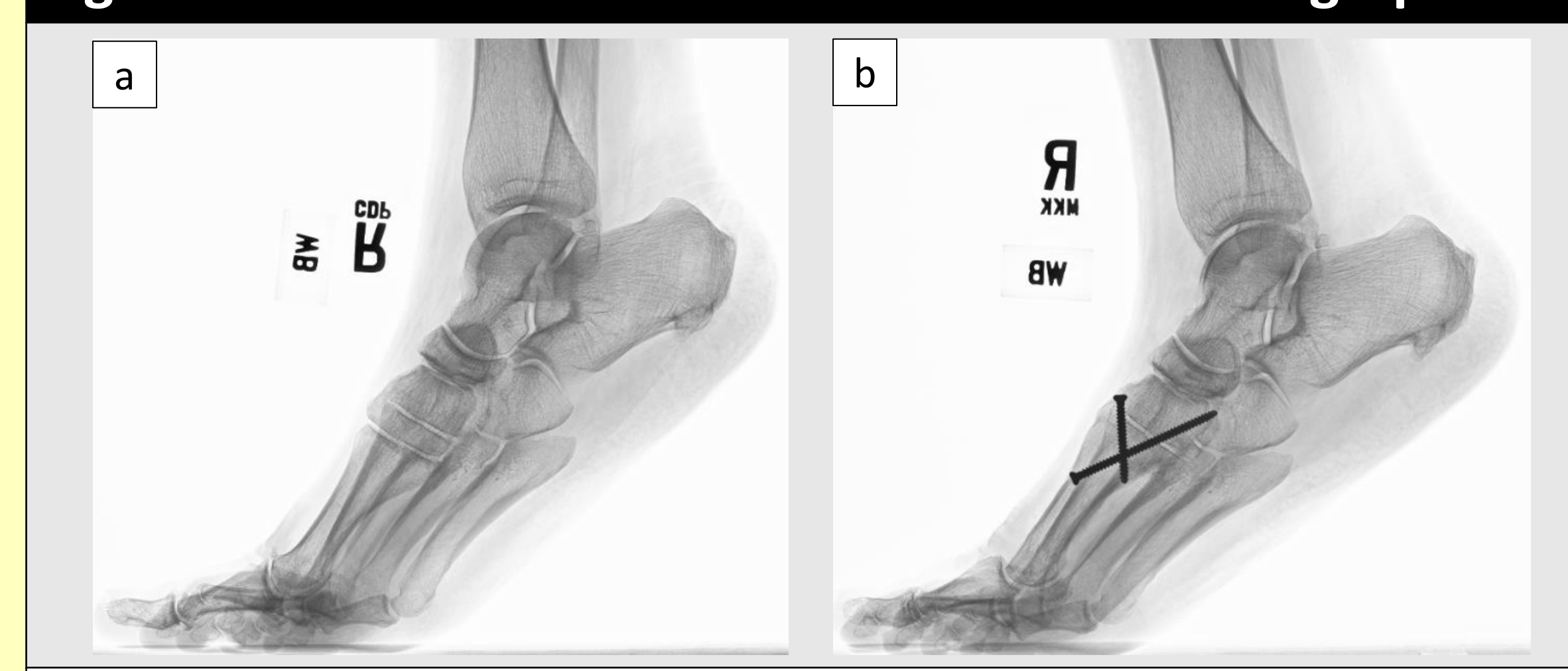
The technique described by Bouaicha et al (5) was utilized in our study to measure MPE. First a circle has to be fit in the metatarsal head so that a congruency between circle and the joint surface can be achieved. Then a tangent line is drawn along the dorsal cortical bone of the first metatarsal shaft. At the proximal point where the circle intersects the tangent line a perpendicular line is drawn through the dorsal cortex of the second metatarsal shaft. The distance between the two intersection points of the two dorsal cortical bones along the vertical line determines the MPE.

**Figure 2. Mid-Stage HR with Severe MPE with Divergence**



First to second metatarsal divergence was included in the inclusion criteria because if little to no divergence is seen on lateral radiograph, then there is potential for a falsely elevated first ray based on poor foot positioning, usually an inverted foot. Dorsal divergence is also associated with severe MPE. All patients included in the study had dorsal divergence of the 1<sup>st</sup> metatarsal preoperatively (a) and 10/10 feet had no divergence at 10 weeks and 1 year postoperatively (b).

**Figure 3. Lateral Hallux Stress Dorsiflexion Radiograph**



(a) Preoperative lateral hallux stress DF view. Note intact dorsal joint space with maximum functional DF, consistent with mid-stage HR. (b) Improved maximum functional DF is demonstrated at 1 year status post 1<sup>st</sup> TMTJ arthrodesis with cheilectomy.

- Exclusion criteria: under the age of 18 years, stage 1 or stage 4 HR, prior 1<sup>st</sup> ray surgical correction, current or prior foot & ankle trauma, infection, rheumatoid arthritis, diabetes mellitus, peripheral vascular disease, or peripheral neuropathy

## Statistical Analysis:

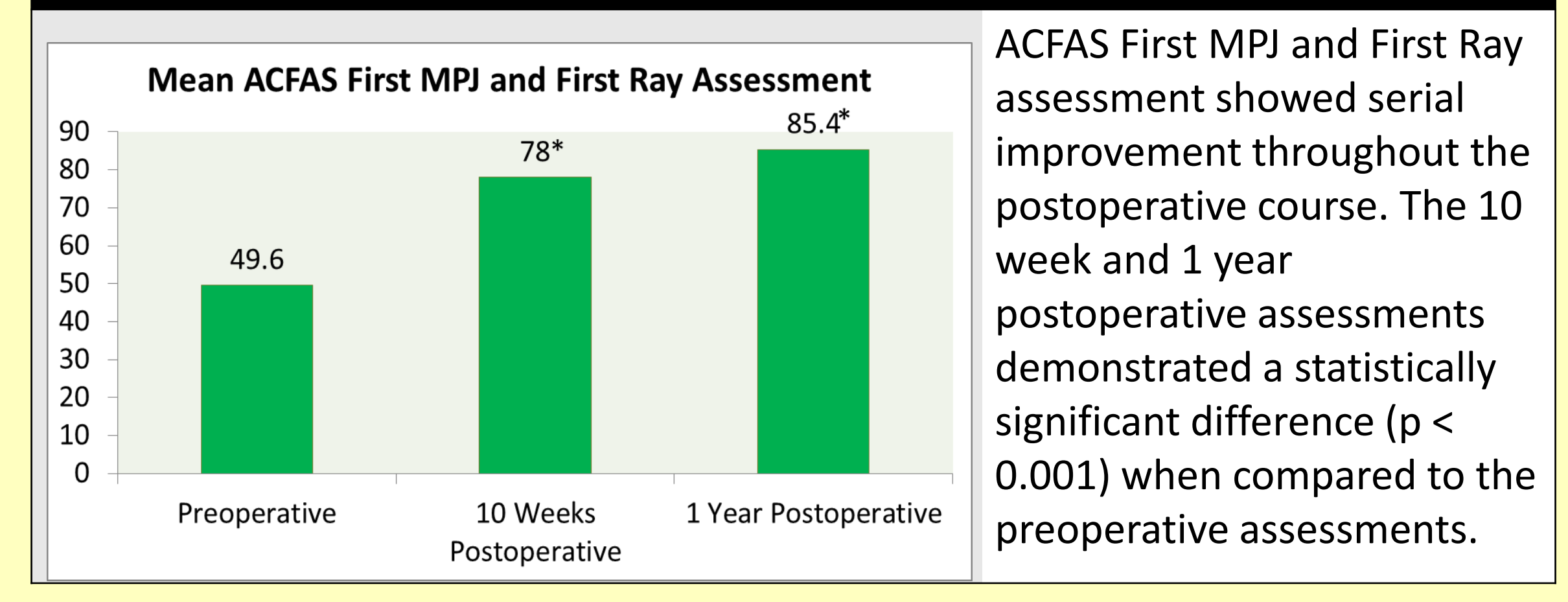
- Continuous variables were described in terms of the mean  $\pm$  standard deviation (SD), range (minimum - maximum).
- Tests of the null hypothesis were used comparing the preoperative to postoperative outcomes, and statistical significance was set at  $p \leq 0.5$ .

**Table 1. Patient Characteristics (\*9 patients, 10 feet)**

Gender (Male:Female)	2 (22.2%) : 7 (77.8%)
Mean Age (years)	50.4 (28 to 61)
Laterality (Right:Left)	7 (70%) : 3 (30%)
Follow-up Time (months)	21.9 (12 to 52)
Comorbidities	
Vit D Deficiency	2
Hypothyroidism	1

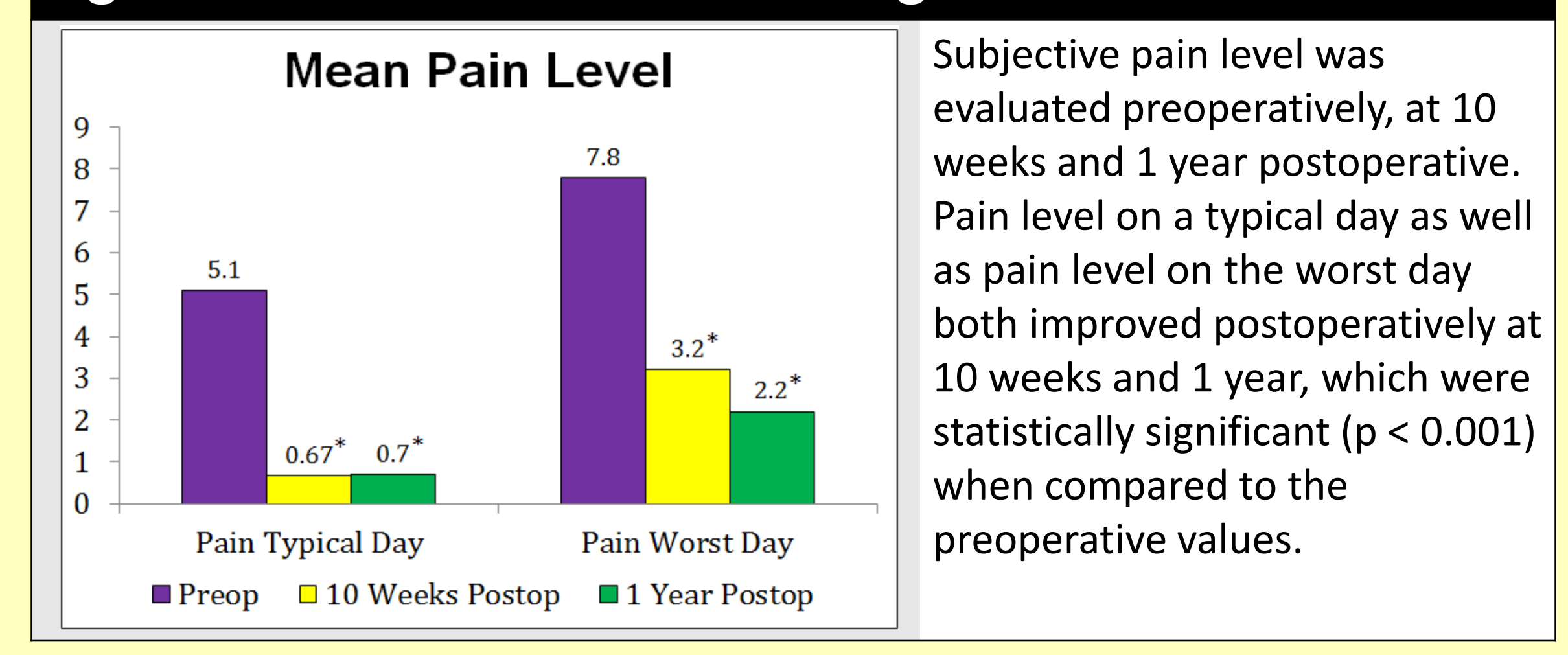
\*1 patient/foot excluded due to intra-operative decision for 1st MTP joint fusion

**Figure 4. Mean Improvement of ACFAS First Ray Score**



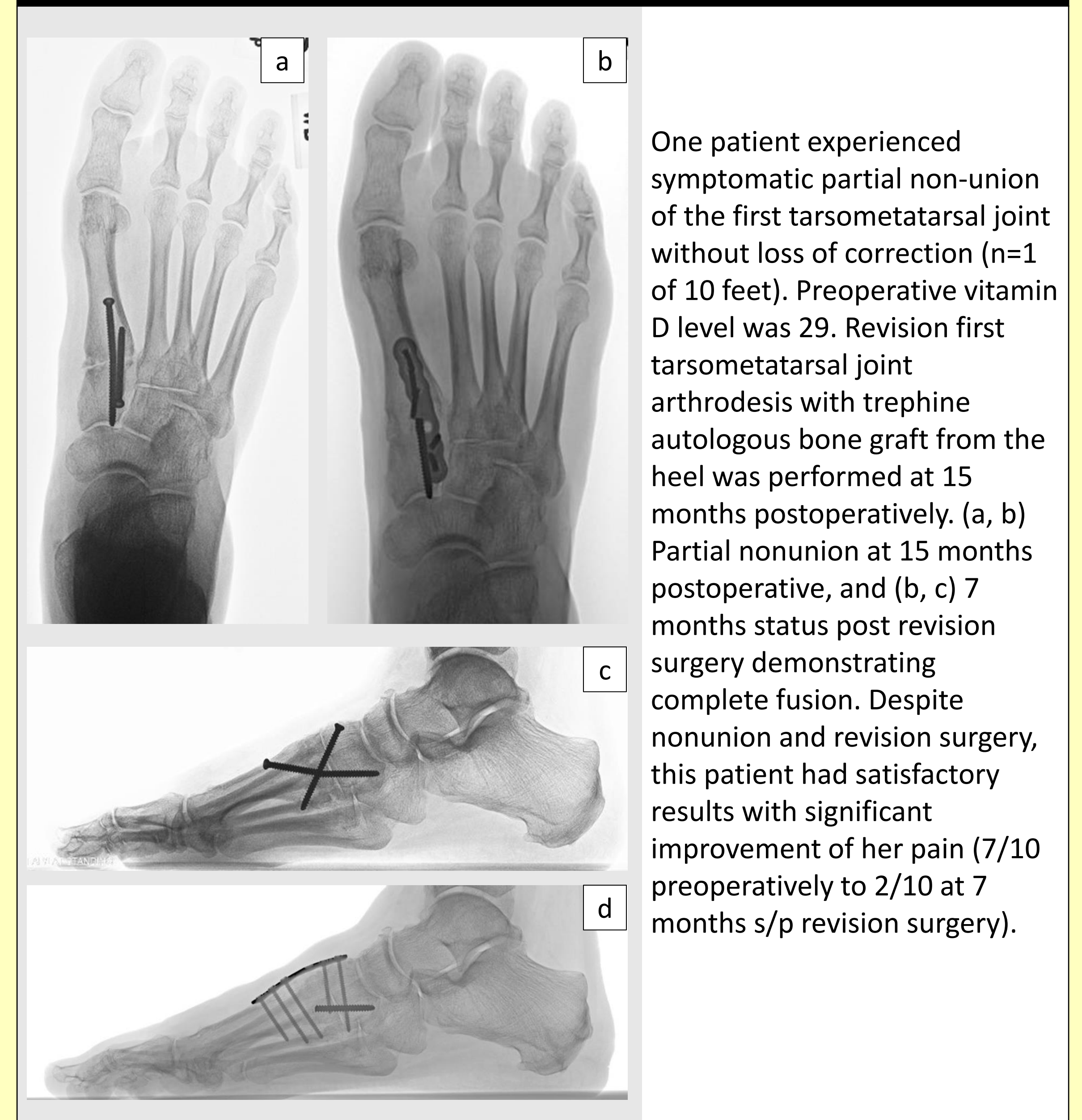
ACFAS First MPJ and First Ray assessment showed serial improvement throughout the postoperative course. The 10 week and 1 year postoperative assessments demonstrated a statistically significant difference ( $p < 0.001$ ) when compared to the preoperative assessments.

**Figure 5. Mean Pain Level Utilizing VAS Scores**



Subjective pain level was evaluated preoperatively, at 10 weeks and 1 year postoperative. Pain level on a typical day as well as pain level on the worst day both improved postoperatively at 10 weeks and 1 year, which were statistically significant ( $p < 0.001$ ) when compared to the preoperative values.

**Figure 6. One Complication Identified Involving Partial 1<sup>st</sup> TMTJ Nonunion Treated with Revision Surgery**



One patient experienced symptomatic partial non-union of the first tarsometatarsal joint without loss of correction (n=1 of 10 feet). Preoperative vitamin D level was 29. Revision first tarsometatarsal joint arthrodesis with trephine autologous bone graft from the heel was performed at 15 months postoperative. (a, b) Partial nonunion at 15 months postoperative, and (b, c) 7 months status post revision surgery demonstrating complete fusion. Despite nonunion and revision surgery, this patient had satisfactory results with significant improvement of her pain (7/10 preoperatively to 2/10 at 7 months s/p revision surgery).

## Outcomes of Interest:

- Patient characteristics including gender, age, laterality, stage of HR, level of MPE and complications were recorded.
- The level of MPE was measured preoperatively and 1 year postoperatively.
- ACFAS and VAS scores were compared preoperatively, at 10 weeks and 1 year postoperatively.
- A subjective questionnaire was also given preoperatively, at 10 weeks and 1 year postoperatively to assess improvement in activity level, whether the patient would recommend the procedure to a friend with similar symptoms, and subjective level of satisfaction.

## RESULTS

- Patient characteristics are detailed in Table 1.
- Results of the ACFAS First MPJ and First Ray Assessment are demonstrated in Figure 4.
- Mean pain level improvement utilizing VAS scores are depicted in Figure 5.
- Average MPE preoperatively was 8.85 mm (range 7.5-11.1) and improved to 5.25 mm (range 3.7-6.8) at 1 year postoperatively, a difference that was statistically significant.
- 9/10 patients reported they would recommend the procedures to a friend at 1 year postoperative.
- Complications:
  - 1 Partial nonunion of the 1<sup>st</sup> TMTJ (10%) (Figure 6)
    - Revision 1<sup>st</sup> TMTJ arthrodesis performed at 15 months postoperative
  - No other complications identified (0%): 1<sup>st</sup> ray overload, infection, neuritis, DVT/PE or recurrent deformity

## ANALYSIS & DISCUSSION

- A variety of procedures have traditionally been advocated to address the surgical dilemma of HR with MPE, however, few truly address severe elevates or medial column instability.
- This prospective study with intermediate term follow-up demonstrates excellent patient satisfaction and statistically significant improvement in ACFAS First MPJ and First Ray scores as well as level of pain at 1 year postoperatively.
- Limitations include small sample size, lack of control and intermediate term outcomes.
- These preliminary intermediate term outcomes appear promising, however, continued studies with a larger sample size and long-term follow-up are necessary to ultimately provide better understanding of the biomechanical contribution of the first ray to hallux rigidus deformity.

## REFERENCES

- Root ML, Orien WP, Weed JH. Motion of the joints of the foot: the first ray. In Clinical Biomechanics. Volume II: Normal and Abnormal Function of the Foot, pp 46-51, 350-354, edited by SA Root, Clinical Biomechanics, Los Angeles, 1977.
- Meyer JO, Nishon LR, Weiss L, et al. Metatarsus primus elevatus and the etiology of hallux rigidus. J Foot Surg 26:237, 1987.
- Roukis TS. Metatarsus primus elevatus in hallux rigidus: Fact or fiction? J Am Podiatr Med Assoc 95(3):221-228, 2005.
- Horton G, Park Y, Myerson M. Role of metatarsus primus elevatus in the pathogenesis of hallux rigidus. Foot Ankle Int 20:777-780, 1999.
- Bouaicha S, Ehrmann C, Moor BK, et al. Radiographic analysis of metatarsus primus elevatus and hallux rigidus. Foot Ankle Int 31(9):807-813, 2010.
- Drago, J.J., Oloff, L., and Jacobs, A.M. "A Comprehensive Review of Hallux Limitus." J Foot Ankle Surg 23:213-220, 1984.
- Boffeli T, Collier RC. Lateral Stress Dorsiflexion View: A Case Series Demonstrating Clinical Utility in midterm Hallux Limitus. J Foot Ankle Surg ;54(4):739-46, 2015.