

# Early Results of Immediate Weightbearing following 1st Tarsometatarsal Joint Arthrodesis with Plantar Locking Plate and Dorsal Compression Screw Construct for Treatment of Hallux Valgus

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## Abstract

**Background:** Fusion and bridging of the 1<sup>st</sup> tarsometatarsal (TMT) joint is accepted for many indications within the foot and ankle surgical community. 1<sup>st</sup> TMT fusion has been used to primarily correct a bunion during a modified Lapidus procedure. It can be used to stabilize the distal medial column (flatfoot correction), to alleviate 1<sup>st</sup> TMT arthritis pain, and in traumatic injuries the 1<sup>st</sup> TMT can be bridged or primarily fused. Fusion of the 1<sup>st</sup> TMT can plantarflex and decompress the 1<sup>st</sup> metatarsal in hallux limitus, and it can be used in revision procedures. Many approaches to fuse the 1<sup>st</sup> TMT have been reported, including, but not limited to, single/multi screw constructs, dorsal plate and screw, medial plate and screw, two plate construct, plantar plating with incorporated compression screw, plantar plating with a dorsal compression screw, and staples, to name a few. We present our solution to the correction of the **triplane deformity in hallux valgus** with a **plantar locking plate** and dorsal compression screw, allowing **immediate weightbearing** and resulting in **minimal complications**.

**Methods:** Retrospective analysis was performed and charts were reviewed for patients treated at our institution with plantar locking plate at the 1<sup>st</sup> TMT joint. All patients were treated with the same plantar 1<sup>st</sup> TMT plating system by 2 Podiatric Surgeons<sup>(WB,KJ)</sup> in Rockford, Illinois from August 2014 to December 2017. Our indications for use of the plate were analyzed. These included hallux valgus, hallux limitus, flat foot and cavus foot reconstruction, 1<sup>st</sup> TMT arthritis, traumatic injury, 1<sup>st</sup> TMT instability, revision proximal, midshaft, and distal metatarsal procedures, 1<sup>st</sup> TMT revision procedures, and flat foot revision. The rationale for using the plantar plate fixation construct at the 1<sup>st</sup> TMT was often multi-factorial and a primary indication was selected for each patient. For purposes of this study, inclusion criteria were: all surgical patients that underwent TMT1 arthrodesis using the same plantar locking plate and dorsal compression screw during the allotted time period with a primary indication for treatment of hallux valgus. Patients were excluded if they had traumatic injuries, TMT1 arthritis, hallux limitus, 1st ray elevatus/ forefoot supinatus, plantarflexed 1st ray, and revision TMT1 procedure as the primary indication for the surgery without significant hallux valgus deformity. In all, 83 patients underwent surgery with plantar plate fixation but only 43 Females and 6 males underwent surgery to correct for hallux valgus as a primary indication. 4 female patients underwent bilateral surgery on separate dates. 53 index surgical encounters occurred – demographic data in Table 1. Following surgery patients were all allowed to bear weight in a short leg walking cast. Patients were followed for 6 weeks to 3 years. Outcomes were analyzed and included pre-operative VAS and VAS at 12 week follow-up, pre and post operative radiographic imaging (intermetatarsal angle - IMA, tibial sesamoid position - TSP, and standing lateral 1<sup>st</sup> metatarsal angle SLFM) – which was assessed by two independent surgeons (Inter-rater Reliability in Table A.) and any complications that occurred intra-op and post-operatively were noted. Complications anticipated included tibialis anterior tendon rupture, nonunion, delayed union, post-operative infection requiring surgery, hardware removal, dehiscence and iatrogenic hallux varus or overcorrection.

**Results:** In all, 49 patients (53 encounters) reviewed, underwent 1<sup>st</sup> TMT arthrodeses and met the inclusion criteria for a retrospective chart review (Table 1). As noted, 4 female patients underwent bilateral surgery. Follow-up was 6 to 131 weeks and the average age at the time of the intervention was 44 years of age (13 to 68 years). Average preoperative 0-10 VAS scores of 6.84 (range of 4 to 10) were reduced significantly ( $p < 0.001$ ) to a mean 12-week follow-up score of 2.71 (range of 0 to 10). Patients transitioned to their regular shoe gear at 6 weeks postoperatively. Radiographic union was suspected at 6 weeks and confirmed at 12 weeks in 96.27% of cases. No tibialis anterior tendon ruptures or significant tendon weakness occurred as a result of surgery and no significant 1<sup>st</sup> metatarsal elevatus was observed after immediate weightbearing. Furthermore, no hardware failure or screw migration was noted. Radiographic measurements were used to assist in diagnosing union, to confirm preservation of corrected IMA and LSFMA, verify TSP, and indicate any hardware breakage. IMA was reduced on average from a preoperative measure of 17.39 to a postoperative measure of 7.16, significance ( $p < 0.001$ ). Average TSP (7-0) decreased from preoperative score of 6.02 to a postoperative score of 2.71, significance ( $p < 0.001$ ) (Table 2.)

## Surgical Technique

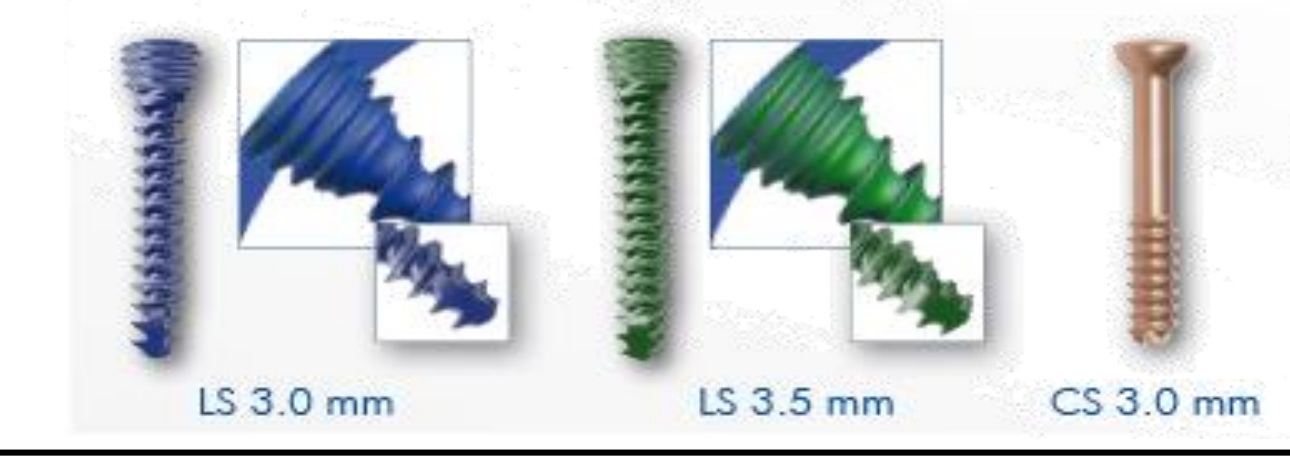
[To correct HAV -Case Example: Pre-operative Radiographs]



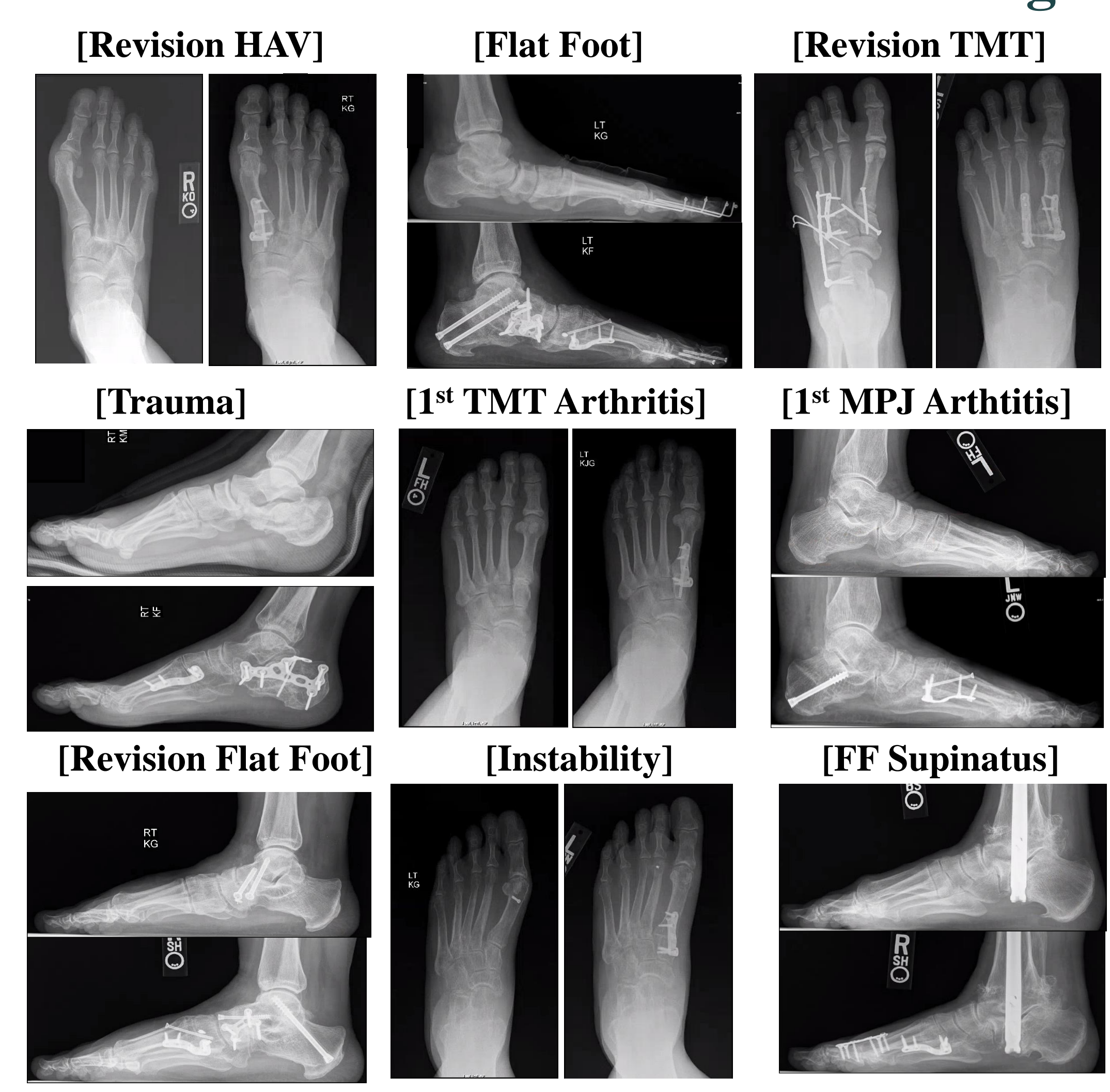
- Incision planning, plantar 1/3<sup>rd</sup> TMT linear incision – 1, 2, 3
- Oblique 1<sup>st</sup> TMT capsulotomy at anterior edge of TA insertion – 4
- Medial 1<sup>st</sup> MPJ capsulotomy and lateral release – 5
- Removal of medial eminence – 6
- Derotation and reduction of IM 1 angle – 7
- TMT joint resection – 8
- TMT joint prep for fusion – 9
- Provisional fixation, placement of dorsal compression screw and medial plantar plate – 10,11,12



[Post-operative Radiographs]



## Other Indications for Plantar Plating



## Plantar Plating for Hallux Valgus



**Table A.** Reliability of Preoperative and Postoperative Radiographic Assessments

Parameter	Reliability
First (metatarsal) angle, Preoperative	0.849
First (metatarsal) angle, Postoperative	0.811
Tibial sesamoid position, preoperative	1.00
Tibial sesamoid position, postoperative	1.00
Lateral standing first metatarsal angle, preoperative	0.755
Lateral standing first metatarsal angle, postoperative	0.698

\* Categorical variable: TSP – A difference of 1 or less was considered agreement. Also, Continuous variables: IMA and LSFMA – A difference of 1° or less considered agreement.

**Table 1.** Retrospective chart review (N=53 feet) with TMT1 arthrodesis in Hallux Abducto Valgus (patients with a plantar locking plate and a dorsal compression screw demography)

Variable	Value
Age	44 (12-60)
Sex	6 (12.4%) Male, 43 (87.6%) Female
Side	29 (54.7%) Left, 24 (45.3%) Right
Adjuvant Procedures	AKH osteotomies 17 (32.0%), Proximal interphalangeal joint fusion/arthrodesis 24 (45.3%), Lesser metatarsal osteotomies 28 (52.8%), Part of revision surgery 4 (7.5%)
Complications	Tibialis anterior ruptures 0 (0%), TMT non-union 1 (1.89%), Delayed TMT union 1 (1.89%), Elevatus of M1 0 (0%)
Follow Up	Weeks 36 (8, 131)

**Table 2.** Comparison of preoperative to postoperative measurements (N=53)

Variable	Preoperative	Postoperative	p-value
Intermetatarsal angle (°)	17.39 (12, 28)	7.16 (3, 12)	.0001
Tibial sesamoid position	6.02 (4, 7)	2.79 (1, 6)	.0001
Lateral standing first metatarsal angle (°)	21.66 (12.50, 29.50)	23.94 (14, 31.80)	.0001
Visual analog scale	5.25	2.71	.0001

\* Mean (minimum, maximum)

## Results continued:

Out of the 53 feet, adjunct procedures included 17 (36.96%) akin osteotomies fused with either screws or staples, interphalangeal joint arthrodesis or arthroplasty were performed on 24 feet (52.17%), 28 feet had (60.87%) had lesser metatarsal osteotomies fixated with screw or k-wire. Furthermore, 4 (8.70%) of feet were corrected as part of revision surgery. Patient reported preoperative and postoperative Visual Analog Scale (VAS) scores were analyzed in patients whose interventions were performed primarily for correction of hallux valgus deformity without adjunct rearfoot osteotomy, tendon transfer or fusion. These scores were analyzed pre-operatively and post-operatively at 12 weeks. Average VAS scores were reduced from 5.25 to 2.13 when comparing pre-procedural survey to post procedural survey at the 12 week follow up appointment for all patients who were immediately weightbearing following surgery and transitioned to normal shoe gear at 6 weeks.

Complication rates for all 53 surgical procedures were analyzed. Tension-side (plantar) plating effectively fused 97.83% of all cases of fusion of TMT 1, with immediate weight-bearing. In all 53 cases there was one case of 1 delayed (1.89%) and 1 non-union (1.89%) recorded at the 1<sup>st</sup> TMT. No cases of Tibialis Anterior Tendon weakening nor any Tibialis Anterior Tendon ruptures were observed. Additionally, no significant dorsal migration has been noticed post operatively in any of the cases in this study. Hardware irritation was reported in 1 case (1.89%) necessitating removal of hardware. There is 1 case (1.89%) of each of the following: Hallux Varus, minor recurrence and minor dehiscence – none of which required further surgery. A total complication rate including all of the aforementioned was 11.34%. The average follow-up for all patients in this study was of 36 weeks.

## Discussion

A discussion can be had regarding tibialis anterior tendon (TA) rupture risk with plantar plating. A recent cadaveric study shows that plantar plating with modified Lapidus arthrodesis can be safely performed without damaging the plantar tendon insertion of the TA.<sup>1</sup> Our study confirms no significant damage to the TA insertion in vivo with no TA ruptures or associated loss of strength post operatively. Outside of the damage to the TA there is a well documented list of other potential complications associated with the 1<sup>st</sup> TMT arthrodesis including but not limited to nonunion, delayed union and dorsal migration of the 1<sup>st</sup> metatarsal (elevatus). These risks are associated with cross screw configuration, dorsal plating, and medial plating. One approach in particular, that is appears to be very common among foot and ankle surgeons, is dorsomedial plating with interfrag screw configuration. This approach is associated with a substantial increase in risk of untoward events reported in the literature. One such study directly compares dorsal medial plating and dorsal interfrag screw vs. plantar plating and dorsal interfrag screw. In 2013 Gutteck et al. found significantly increased risk in bone healing (delayed union) and elevation of the metatarsal post-operatively in patients who underwent dorsal medial plating and interfrag screw when compared to plantar plating with interfrag screw combination.<sup>2</sup> In a single surgeon study, published in 2017, Barp et al. found nonunion rate of 2% for intraplate compression fixation in 48 patients, 5% nonunion for single interfragmentary screw with locking plate fixation in 45 patients, and 9% nonunion rate in 44 patients for crossing solid core screw fixation.<sup>3</sup> Though, that study did have a disproportionately low number of smokers, patients with diabetes and patients with osteoporosis when compared to our patient demographics. Additionally, most patients received demineralized bone matrix and were not allowed to bear weight until 4 weeks post-op, which is a significant burden to most of our surgical patients.

Our surgeons<sup>(WB,KJ)</sup> perform planar resection of the TMT joint, as curettage is associated with increased risk of nonunion according to Hyer et al.<sup>4</sup> which can help to explain our lower rate of nonunion when coupled with the biomechanical superiority of tension side plating.<sup>5</sup> Cottom and Vora report a similar, 2% nonunion rate, with tension side fixation. However, their tension side fixation was in the form of screw and the locking plate was placed medially. In a series of 88 patients their symptomatic hardware removal approached 17%. Moreover, they had an extensive list of exclusion criteria including diabetes, previous Lapidus and 1<sup>st</sup> MPJ arthritis.<sup>6</sup> We included all patients who received plantar plating to treat hallux valgus and had only 1 incidence of hardware removal in 53 feet. In another study, Petterson et al. reported incidence of symptomatic hardware removal after first tarsometatarsal arthrodesis at approximately 15% within a median duration of 9.0 months after surgery when hardware implanted included crossed lag screws or locking plate and lag screw.<sup>7</sup> Again, our removal of symptomatic hardware is much lower. This is likely attributable to dorsal notching in the metatarsal for recession of the headed dorsal compression screw and good coverage of the plantar plate by a substantial amount of muscle and fat plantarily.

## Conclusion:

Our results indicate that optimal correction, low complication rates including a low level of hardware removal, acceptability of early weightbearing, and reduction in pain can be achieved using plantar plating and dorsal compression screw to treat hallux valgus.

## References

1. Plass C, Classen L, Daniilidis K, Fumy M, Stukenborg-Colsman C, Schmiedl A, Eitinger S. **Placement of Plantar Plates for Lapidus Arthrodesis: Anatomical Considerations.** *Foot Ankle Int.* 2016 Apr;37(4):427-32
2. N. Gutteck \*, D. Wohlrab, A. Zeh, F. Radetzki, K.-S. Delank, S. Lebek. **Comparative study of Lapidus bunionectomy using different osteosynthesis methods.** *Foot and Ankle Surgery.* 2013 (19): 218-221
3. Barp E, Erickson J, Smith H, Almeida K, Millonig K. **Evaluation of Fixation Techniques for Metatarsocuneiform Arthrodesis.** *Journal of Foot and Ankle Surgery.* 2017;56(4):468-473
4. Prissel M, Hyer C, Grambart S, Bussewitz B, Brigido S, DiDomenico L, Lee M, Reeves C, Shane A, Tucker D, Wierman G. **A Multicenter Retrospective Study of Early Weightbearing for Modified Lapidus Arthrodesis.** *Journal of Foot and Ankle Surgery* 2016 (55): 226-229
5. Klos K, Simmons P, Hajduk A, Hoffmeier K, Ing D, Gras F, Frober R, Hoffmann G, Muckley T. **Plantar vs Dorsomedial Locking plating for Lapidus Arthrodesis: A Biomechanical Comparison.** *Foot and Ankle Int.* 2011 Nov;32(11):1081-1085
6. Cottom J, Vora A. **Fixation of Lapidus Arthrodesis with Plantar Interfragmentary Screw and Medial Locking Plate: A Report of 88 Cases.** *Journal of Foot and Ankle Surgery.* 2013 (53): 465-469
7. Petterson K, McAllister J, Hyer C, Thompson J. **Symptomatic Hardware Removal after 1<sup>st</sup> Tarsometatarsal Arthrodesis.** *Journal of Foot and Ankle Surgery.* 2016 (55): 55-59

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