

# Utilization of a Custom Foot Mold for Optimal Intraoperative Positioning in Rearfoot Fusion

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## Statement of Purpose

Appropriate rearfoot positioning for hindfoot arthrodesis determined intraoperatively is a subjective measurement based upon the pre-operative radiographic and physical examination. Consequently, the patient's lower extremity is non-weight bearing on the operating room table, posing additional difficulty in accurate representation of joint position.

The study at hand will investigate a reproducible method to provide an optimal position of the rearfoot prior to fixation. This involves the replication of the patient's rearfoot neutral positioning obtained on a pre-operative weight bearing examination. The device utilized in this technique allows the appropriate position to be maintained while internal fixation is placed. The appropriate position will place the patients rearfoot joints in neutral alignment for optimal outcomes in terms of pain relief and functional improvement. We hypothesize that a neutral alignment of the rearfoot can be obtained preoperatively and replicated intraoperatively by the use of a custom molded foot orthoses with results similar to those treated by conventional methods. We aim to investigate both the functional and radiographic improvement obtained in the short-term follow-up period for those having undergone correction by use of this technique.

## Methodology & Procedures

IRB approval was obtained for a retrospective investigation into patient's health information. Medical records were searched for CPT 28725 arthrodesis Subtalar Joint (STJ) and CPT 28740 arthrodesis midtarsal (talonavicular, TNJ) over dates 01/2013 – 08/2019 at UF Health Jacksonville. Patients over age 18 having undergone above named procedures with use of intraoperative foot mold, within the date range, with a minimum of 1-year postoperative follow-up and the appropriate weight bearing imaging at each interval visit met the inclusion criteria for the study. Those under age 18, inadequate follow-up or imaging were excluded.

Using a Custom Foot Alignment Device, a weight-bearing rearfoot position was obtained that restores anatomical relationships to the forefoot, midfoot, hindfoot, ankle, knee and back (Figure 1). A mold is created from this custom foot template for use intraoperatively, patient pending (Figure 2). Following joint preparation, the foot is held in this position using this device to simulate weight bearing on the operating room table. The appropriate alignment is then fixated while the device is applied to the foot to maintain the correction (Figure 3).

Pre- and Post-operative weight bearing X-Ray images of the operative foot were obtained for evaluation. LEFS and AOFAS rearfoot scores were obtained at follow-up intervals (pre-operative, 12-weeks, 6-months and 1-year) to measure improvement.

## Methodology & Procedures



Figure 1: Pre-operative weight bearing evaluation and custom mold fabrication

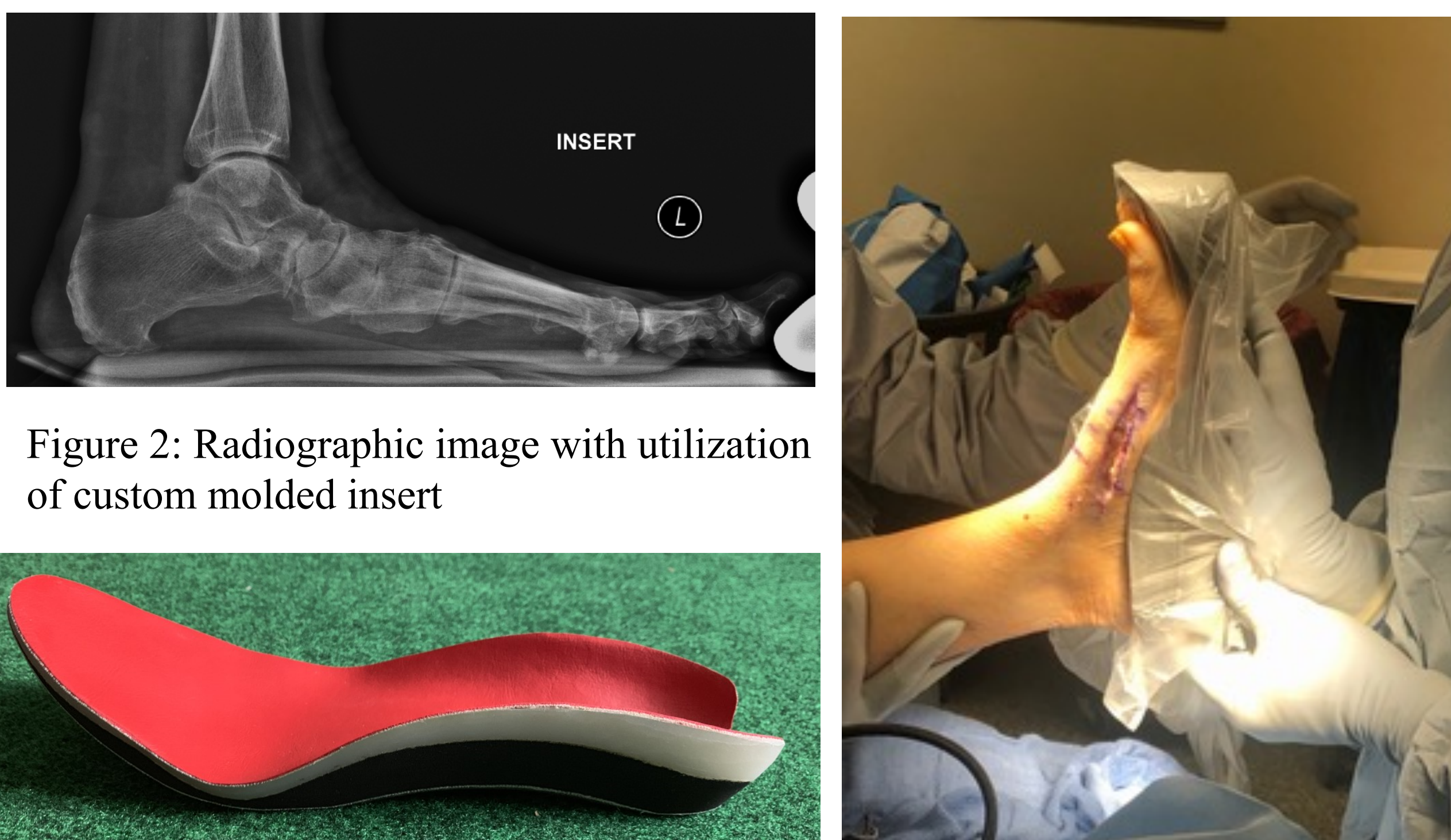


Figure 2: Radiographic image with utilization of custom molded insert

Figure 3: Custom foot mold fabricated for use in the intra-operative setting

Figure 4: Intra-operative simulated weight bearing with fixation following joint preparation.

## Literature review

Inaccurate rearfoot positioning can lead to undesirable frontal plane deformities (1,2). Seybold and Coetzee described positioning of the triple arthrodesis as “restoring a plantargrade foot and approximately 5 of hindfoot valgus alignment” (3). There is correlation to operation success in STJ fusions when correct heel to ground relationships are made (4). Techniques to provide appropriate positioning of the rearfoot complex prior to arthrodesis are limited in current literature. Commonly, intraoperative manual manipulation to get STJ neutral is employed (2). In 2013, Laporta et al described the use of external fixation for distraction and rearfoot alignment during placement of allograft for STJ arthrodesis. This was found to be viable maintenance of alignment during internal fixation application (5). Firoozabadi et al utilized external fixation for correction of deformity and maintenance of alignment for joint fixation (6). External fixation poses additional considerations like pin-site infections, cost, and risk of damage to surrounding structures.

## Results

5 patients met the inclusion criteria with TNJ and STJ fusion performed on a total of 5 feet, 4 left (80%) and 1 right (20%). Average age at time of surgery was 50 years old (range 36 – 74 years) and was comprised of 2 Male (40%) and 3 female (60%) patients. There was statistically significant improvement in AOFAS and LEFS scores at 6-month and 1-year follow up as compared to pre-operative values. Radiographic angles showed improvement in each subject (Table 2 & 3). Delayed union or non-union complications were not found. No soft tissue complications were noted within the post-operative period.

Subject	AOFAS Hindfoot				LEFS			
	Pre-Op	12 Weeks	6 Months	1 Year	Pre-Op	12 Weeks	6 Months	1 Year
1	31	64	80	73	25	56.25	68.75	75
2	60	38	78	91	62.5	47.5	82.5	91.25
3	30	33	63	79	37.5	47.5	53.75	72.5
4	12	51	71	73	25	33	37.5	75
5	42	82	80	87	43	88.75	92.5	92.5
Average:	35	53.6	74.4	80.6	38.6	54.6	67	81.25
P-value:		0.156738	0.0017	0.0008		0.205644	0.0461	0.0008

Table 1: AOFAS Hindfoot and LEFS scores at each interval follow-up visit, (P value < 0.05 is statistically significant pre-op versus interval follow-up period)

Subject	Pre- vs. Post-op Radiographic Improvement (degrees)			
	CIA	CAA	Talar Declination	Meary's Angle
1	8.5	1.3	1.6	0.5
2	4.9	15.6	1.1	0.2
3	8.3	13.6	23.4	28.8
4	5.82	5.1	1.6	2
5	4.7	3.3	11.2	13.4
Average:	6.444	7.78	7.78	8.98

Table 2: Radiographic evaluation with average improvement. CIA = Calcaneal Inclination Angle, CAA = Cuboid Abduction Angle.

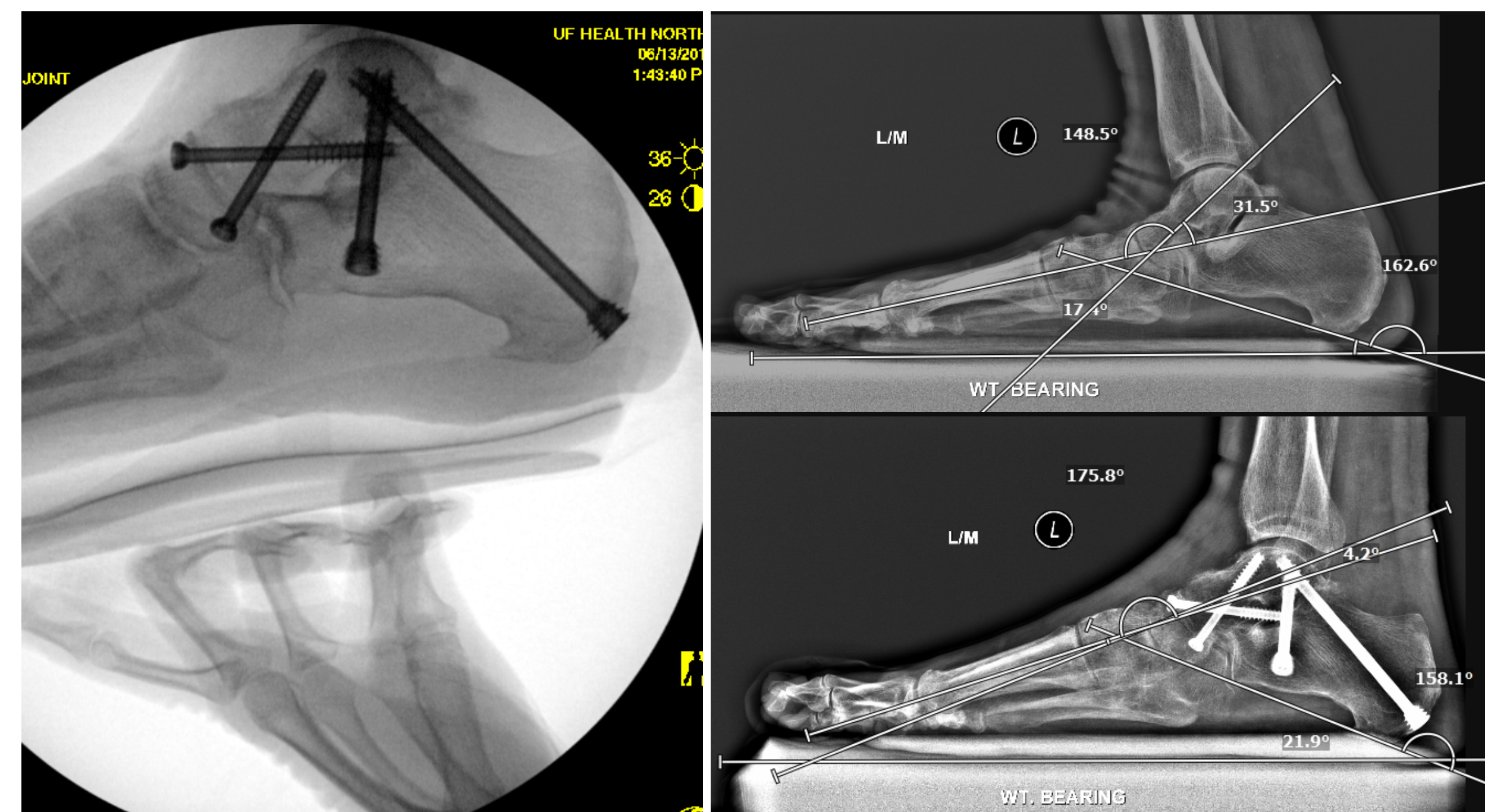


Figure 5: Intraoperative placement of custom molded foot device.

Figure 6: Pre- versus post-operative radiographic evaluation

## Analysis & Discussion

Many surgical procedures aim to restore a neutral rearfoot alignment that is based upon “normal” radiographic angles rather than attention to the patient's forefoot/rearfoot and even proximal anatomical relationships. More specifically, a theory has been described in the literature referred to as the kineticokinematic approach to evaluating perioperative correction (7). The “kinematic” aspect of correction is based solely on restoring normal radiographic angles, whereas the “kinetic” aspect of correction takes into consideration the specific deforming force that led to development of the underlying pathology. When correcting alignment against the deforming force (i.e. weight bearing) with a device such as a molded orthotic, you are able to functionally and dynamically challenge the force with the added benefit of real time patient's subjective satisfaction. Comparing this to intraoperative radiographic evaluation, results may reveal corrected angle measurements but may not lead to an increased functional improvement post-operatively. Intraoperatively, anatomical relationships are typically restored to a reported acceptable range, however a particular patient's ideal measurement may be altered in the presence of underlying deforming factors.

The results obtained through the use of this technique show a statistically significant improvement in terms of improvement of functional outcome. Based on the results of this small patient cohort, we have seen promise in this method.

## References

1. Yu GV. Rearfoot Arthrodesis: The Podiatry Institute Technique. Chapter 4. 20-29, 1996.
2. Wallin K, Green D. Keys to intraoperative Positioning for Subtalar Joint Procedures. Podiatry Today. 25 (5). 32-36. May 2012.
3. Seybold, J. D., & Coetzee, J. C. (2016). Primary Triple Arthrodesis for Management of Rigid Flatfoot Deformity. JBJS Essential Surgical Techniques, 6(3), e29. doi: 10.2106/jbjs.st.16.00009 Tuijthof GJ, Beimers L, Kerkhoffs GM, Dankelman J, Dijk CN. Overview of subtalar arthrodesis techniques: options, pitfalls and solutions. Foot Ankle Surg. 2010;16(3):107-16.
4. Tuijthof GJ, Beimers L, Kerkhoffs GM, Dankelman J, Dijk CN. Overview of subtalar arthrodesis techniques: options, pitfalls and solutions. Foot Ankle Surg. 2010;16(3):107-16.
5. LaPorta, G., Bock, F., & Ghate, N. (2013). Posterior Approach for Subtalar Joint Distraction Arthrodesis by Compact External Fixation: A Technique Guide. The Journal of Foot and Ankle Surgery, 52(4), 547-552. doi:10.1053/j.jfas.2013.01.010
6. Firoozabadi, R., Thuillier, D., & Benirschke, S. (2017). Obtaining Correct Ankle Alignment Using Intraoperative External Fixation for Ankle Arthrodesis. The Journal of Foot and Ankle Surgery, 56(2), 242-246. doi:10.1053/j.jfas.2016.11.016
7. Shapiro, J. Biomechanical Decision Making – The KK Approach Part 3, Choosing Surgical Procedures. Present Podiatry, Practice Perfect 670. Issue 94. September 3, 2019.