# A radiographic retrospective comparison of allograft and titanium wedges in the Evan's calcaneal osteotomy.

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## Statement of Purpose

The purpose of this study is to compare the radiographic correction obtained utilizing the traditional allograft wedge with an innovative porous titanium wedge when used in the Evans calcaneal osteotomy. The writers of this study hypothesize that there will be greater correction using the titanium wedge due to its standardized specifications.

## Methodology and Procedures

22 feet with pes planus were radiographically evaluated pre-operatively and at first weight bearing post-operatively. 9 patients received the porous titanium wedge and 13 received an allograft wedge. 16 patients were female and 6 patients were male. The average age of allograft patients was 38. The average age of the titanium wedge patients was 49. The right foot was operated on in 14 cases and the left foot was operated on in 8 cases. The postoperative measurements analyzed at first weight bearing lateral radiograph included: calcaneal inclination (CI) and Meary's talo-1$^{st}$ metatarsal angle. The postoperative measurements analyzed at first weight bearing AP radiograph included: AP Meary's, Calcaneal-cuboid (CC), and Kite's angle (TC). The final measurements were compared with published angles from a 2016 paper by Lamm et al. Age, sex, additional procedures, laterality, and complications were also evaluated when reviewing each patient.

The pre-operative and post-operative angle measurements were calculated using the t-tests for dependent variables. Throughout the study, a 2-tailed *p* value ≤ 0.05 was considered statistically significant.

A preliminary look at the time to healing was performed. Of the 22 feet studied, 14 were thought to have sufficient bone growth across the osteotomy site to consider the allograft or titanium wedge incorporated. 7 of the 9 titanium wedges and 7 of 13 of the allograft wedges were compared for this portion of the study.

Image 1 – AP with titanium wedge


Image 2 – Lateral with titanium wedge


Image 3 – Medial Oblique with titanium wedge


## Literature Review

Pes planus is most commonly caused by posterior tibial tendon dysfunction (PTTD). PTTD is a progressively deforming pathology caused by elongation and degeneration of the posterior tibial tendon. PTTD results in hindfoot valgus, collapse of the longitudinal arch, and abduction of the forefoot.[1,2,3] Many surgeons have attempted to correct these deformities with the Evans calcaneal osteotomy, as well as other osseous and tendinous procedures.

In 1975, Evans published a paper on the surgical management of the calcaneovalgus deformity in pediatric patients.[4,5] To achieve correction, it was important to equalize the two columns by making an osteotomy in the neck of the calcaneus 1.5 cm from the calcaneocuboid joint. A tricortical allograft of bone was taken from the tibia and placed in the osteotomy to lengthen the lateral column.[6,7] A contemporary porous titanium allograft consisting of three dimensional, open-celled scaffolding for bone ingrowth presents a new alternative to the autograft and allograft. The osteoconductive property of this titanium wedge is used to enhance the potential for bone integration and also attempts to decrease any loss of correction obtained during surgery.

Limb deformity principles are essential for pre-operative surgical planning. These geometrically based principles originate from standardized radiographic angles and reference points. Lamm et al. defined foot and ankle radiographic angles and reference points using consistent nomenclature in a comprehensive manner using all three radiographic angles used in an everyday setting.[8,9,10] With these principles in mind, it is possible to examine the pre-operative radiograph and set a goal for how much correction must be obtained.[11] Also, it is possible to evaluate a post-operative radiograph to determine if the correction obtained intra-operatively was sufficient for the patient's deformity.[12.13]

## Analysis and Discussion

Both porous titanium wedge and allograft significantly corrected the tri-planar deformity of pes planus at first weight-bearing post-op. The time to healing favored the allograft with a three-week advantage over titanium wedge. This could be attributed to the age difference seen between the allograft and titanium wedge. The allograft was used on patients one decade younger, on average, than the titanium wedge. One of the measurements not included in this study is the tibial calcaneal angle; one of the lead surgeons does not routinely have calcaneal axial views in his post-operative imaging studies. Removing those cases from the study would have made the sample size too insignificant to gain any insight into the practicality of the titanium wedge. Further follow up on the mid- to long-term results of angular correction are needed to fully assess the advantages of each wedge in the Evans calcaneal osteotomy.

## Results

Average correction obtained in porous titanium was 9.8$^0$ decrease of CC, 5.5$^0$ decrease in AP Meary, 3.7$^0$ decrease in TC, 11.7$^0$ decrease in lateral Meary, and an increase of 8.1$^0$ in the CI. Average correction obtained in allograft was 10.7$^0$ decrease of CC, 2.9$^0$ decrease in AP Meary, 3.9$^0$ decrease in TC, 8.2$^0$ decrease in lateral Meary, and an increase of 3.5$^0$ in the CI. These measurements, the pre-operative and post-operative values, are broken down further in Figure 2.

Correction obtained was statistically significant for all angles measured except for titanium Kite angle and allograft AP Meary angle.

Time to healing was 133 days for the titanium wedge and 110 days for the osseous allograft.

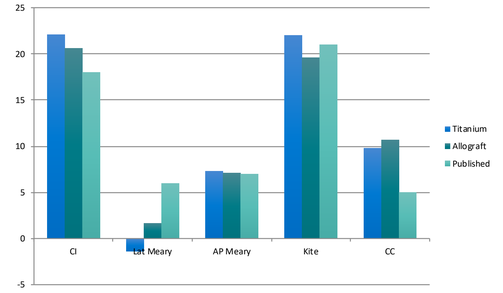
### Figure 1

| Radiographic Angle | Pre-Operative | Post-Operative | Change | P-Value |
|---|---|---|---|---|
| Calcaneal inclination | 15.8 (5 to 24) | 21.2 (10.5 to 29.6) | 5.4 (-0.6 to 17.9) | >0.001 |
| Titanium Wedge | 14.1 (5 to 22.4) | 22.1 (10.5 to 29.6) | 8.1 (2.7 to 17.9) | 0.001 |
| Allograft Wedge | 17.1 (12.2 to 24) | 20.6 (13.4 to 26.1) | 3.5 (-0.6 to 7.8) | 0.001 |
| Lateral Meary | 10.0 (1.5 to 22.4) | 0.4 (-10.9 to 15.3) | 9.6 (1.1 to 16.5) | >0.001 |
| Titanium Wedge | 10.3 (4.9 to 17.5) | (-)1.4 (-10.9 to 7.1) | 11.7 (1.1 to 16.3) | >0.001 |
| Allograft Wedge | 9.9 (1.5 to 22.4) | 1.7 (-3.8 to 15.3) | 8.2 (1.5 to 16.5) | >0.001 |
| AP Meary | 11.2 (3.2 to 20.8) | 7.2 (0 to 17.6) | 3.9 (-12.1 to 17.5) | 0.02 |
| Titanium Wedge | 12.8 (4.9 to 20.8) | 7.3 (2.9 to 15.1) | 5.4 (-5.2 to 17.5) | 0.04 |
| Allograft Wedge | 10.0 (3.2 to 20.4) | 7.1 (0 to 17.6) | 2.88 (-12.1 to 16.1) | 0.2 |
| Kite TC Angle | 24.4 (13.8 to 34.1) | 20.6 (12.9 to 34.5) | 3.8 (-6.6 to 13.7) | >0.001 |
| Titanium Wedge | 25.7 (21.4 to 34.1) | 22.0 (13.3 to 29.4) | 3.7 (-6.6 to 13.7) | 0.07 |
| Allograft Wedge | 23.5 (13.8 to 33) | 19.6 (12.9 to 34.5) | 3.9 (-1.5 to 12.3) | 0.006 |
| CC Angle | 24.0 (13.1 to 32.3) | 13.7 (0 to 25.1) | 10.3 (2.3 to 25.7) | >0.001 |
| Titanium Wedge | 19.6 (13.1 to 32.3) | 9.8 (0 to 20.6) | 9.8 (2.3 to 25.7) | 0.002 |
| Allograft Wedge | 27.1 (18.4 to 32.3) | 16.4 (7.9 to 25.1) | 10.7 (5.6 to 16.2) | >0.001 |

### Figure 2

| | |
|---|---|
| Total Patients | |
| Allograft | 13 (60%) |
| Titanium | 9 (40%) |
| Sex | |
| Female | 16 (73%) |
| Allograft | 8 (36%) |
| Titanium | 8 (36%) |
| Male | 6 (27%) |
| Allograft | 5 (23%) |
| Titanium | 1 (5%) |
| Laterality | |
| Left | 8 (36%) |
| Allograft | 5 (23%) |
| Titanium | 3 (14%) |
| Right | 14 (64%) |
| Allograft | 9 (40%) |
| Titanium | 5 (23%) |
| Average Age | |
| Allograft | 37.85 years |
| Titanium | 48.67 years |
| Entire Study | 42.27 years |
| Complications | |
| Allograft | 2 (15%) |
| Titanium | 1 (11%) |
| Time to Healing | |
| Allograft | 110.625 days |
| Titanium | 133.143 days |

**Post-Operative Angles as Compared to Literature**

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