

Bone Allograft Implant as an Alternative Method for PIPJ Arthrodesis: A Retrospective Case Series

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Statement of Purpose & Literature Review

Hammertoes can be considered one of the most common types of deformity of the forefoot that require surgical intervention¹. Traditional correction of lesser digital deformities consisted of a variety of techniques including arthrodesis of the proximal phalangeal joint (PIPJ) typically held in place by Kirschner wires^{1,2}. More recently alternative methods for PIPJ arthrodesis have evolved to a variety of implants including metallic, bio-absorbable and bone allograft implants in an effort to facilitate a more rigid, stable fixation across the arthrodesis site while reducing the risk of pin tract infections and incidence of delayed or non-unions at the osteotomy site.

Although arthrodesis of the PIPJ is well described in literature, there is limited published research regarding the subject of PIPJ fusion with allograft implants specifically indicated for these procedures. One study reported 30 digital PIPJ arthrodesis in 42 patients performed using an Allofix® cortical bone allograft pin which resulted in complete fusion of all 30 digits uneventfully³. In a second study using the same Allofix® cortical bone allograft pin for PIPJ arthrodesis on 26 digits in 18 patients, 25 of the 26 digits resulted in fusion uneventfully⁴. Lastly, only a single study was found utilizing the TenFUSE® allograft alone where PIPJ arthrodesis was performed on 63 digits in 32 patients resulting in a fusion rate of 97% with the remaining 3% within healing phase, all without complications reported⁵. The purpose of our study was to investigate the rate of successful unions observed in patients where a PIPJ arthrodesis was performed using bone allograft implant specifically designed for this procedure.

Methodology

Billing records were searched to identify patients who had undergone PIPJ arthrodesis between December 2015 and June 2017. Inclusion criteria dates were established to collect only patients who were at least 1 year post-operative. Other inclusion criteria in our study were as follows: patients exhibited a rigid deformity at the level of the PIPJ prior to the surgery, digital contractures presenting solely as an isolated deformity or in conjunction with other abnormalities in the forefoot (i.e. hallux abductovaglus, multiple digital contractures, etc.), failed arthroplasty, and/or a failed implant. All patients who underwent surgical intervention failed a prior period of conservative treatment, such as injection therapy and/or taping/strapping. Patients with flexible hammertoe deformities were excluded from the study. Other means of fixation for the arthrodesis of the PIPJ, such as intramedullary implants and K-wire fixation, were also excluded from the study. There were 26 patients who met the inclusion criteria; however, 16 failed to follow up at least 1 year post-operatively and were excluded from the study. A total of 10 cases were retrospectively reviewed, representing total of 14 allograft implants were used for PIPJ arthrodeses.

Patients who underwent a PIPJ arthrodesis with allograft implant along with a 1st MTPJ fusion with internal fixation or Lapidus fusion with internal fixation were placed in a below-the-knee cast for a total of 6-8 weeks post-operatively. These patients were instructed to non-weight bear to the operative foot and used either crutches, a knee roller, or wheelchair for assisted ambulation. Patients that underwent a PIPJ arthrodesis with allograft implant, either as an isolated procedure or in conjunction with a 1st metatarsal osteotomy with internal fixation, Weil osteotomy with internal fixation and/or multiple PIPJ arthrodesis with allograft implant, were placed in a post-operative surgical shoe and permitted to partial weight bear to the heel.

Patients followed up in the senior author's private office at 1 week, 2 weeks, 1 month, 6 months and 12 months post-operatively (Figures 4a-f). At each appointment, 3 standard radiographic views (AP, MO, and Lateral) were taken. The senior author evaluated each radiograph and documented the findings. We defined a successful union period as a fusion bridging across 2 cortices.

Surgical Procedure

Authors in this case series used a traditional dorsolateral incision over the PIPJ. Soft tissue dissection of was performed down to the extensor digitorum longus. At that point, a transverse tenotomy was made at the PIPJ. The collaterals were then released at the PIPJ, thus exposing the head of the proximal phalanx and base of the middle phalanx. Sagittal saw was utilized to remove the head of the proximal phalanx as well as the cartilage off the base of the middle phalanx preparing the proximal interphalangeal joint for fusion. At this point, we selected the appropriate allograft implant and followed protocol for fixation at the fusion site (Figure 1 & 2). A mini C-arm was utilized to confirm positioning and apposition of the fusion site (Figure 3). All incision sites were flushed with copious amounts of sterile saline. Patient was then placed either in a bi-valve cast, and instructed to non-weight bear for 6-8 weeks or they were placed in a post-op surgical shoe, and were permitted to partial weight bear to the heel.

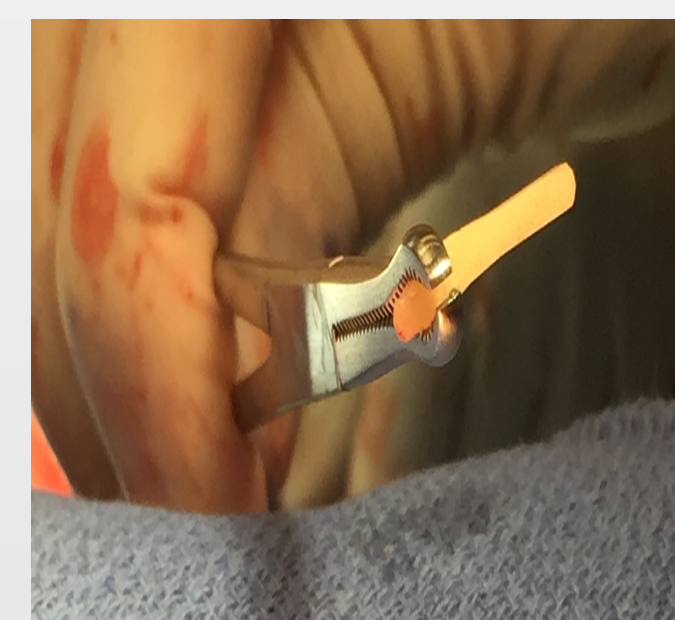


Figure 1

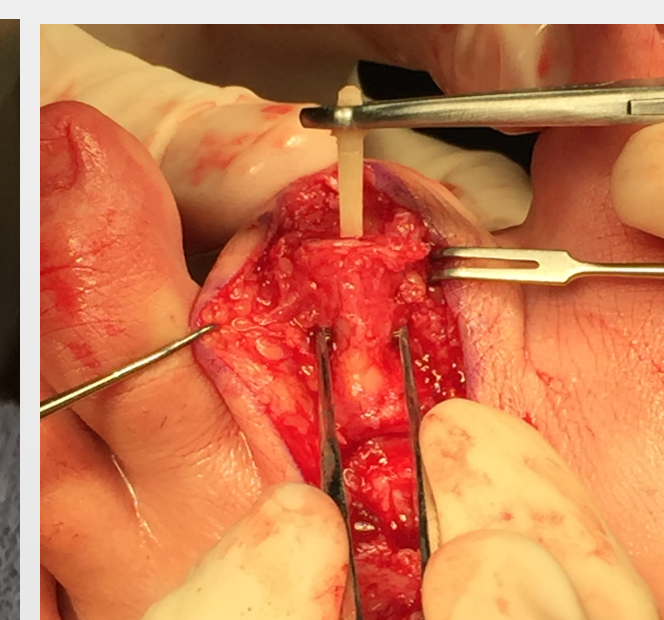


Figure 2

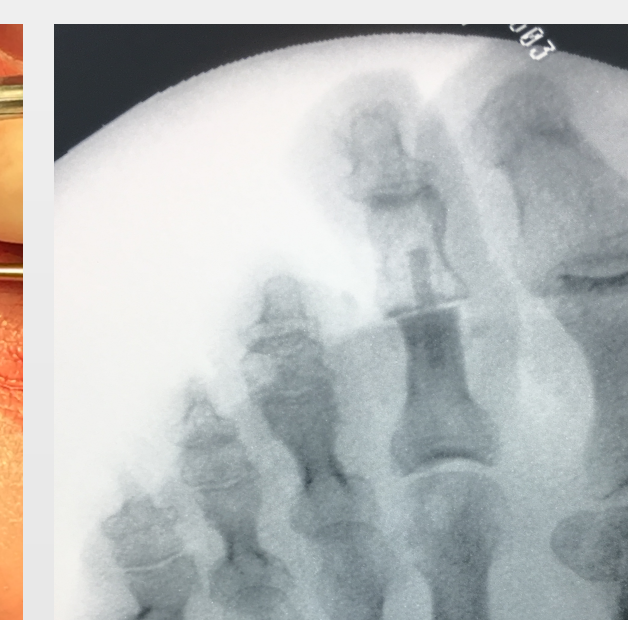


Figure 3

Results

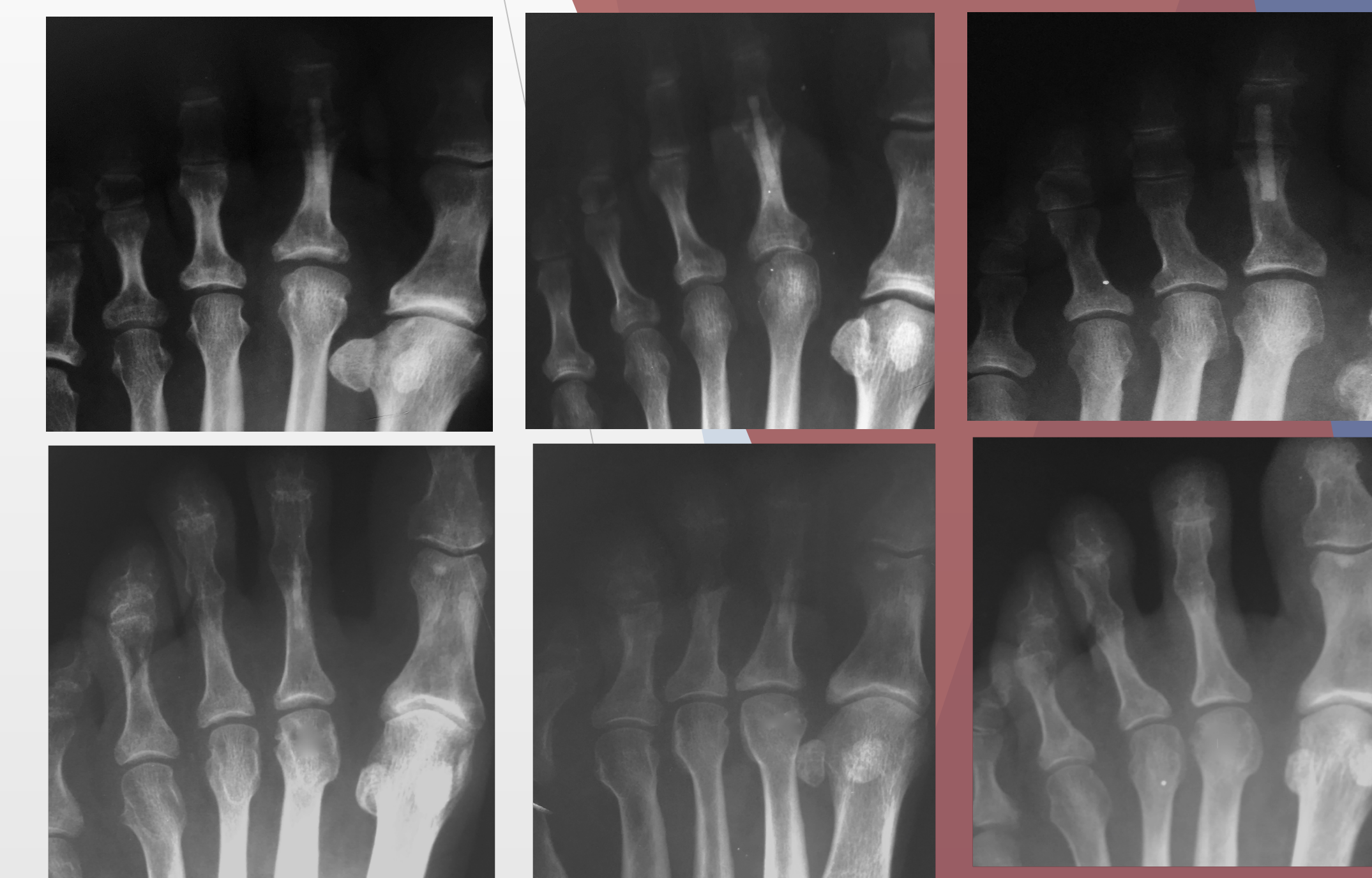
All 14 PIPJ fusions with allograft implants reviewed in this study demonstrated successful unions (100%). Nine of the 14 fusions were of the 2nd digit (64.2%), 4 were of the 3rd digit (28.5%), and 1 of the 4th digit (7.1%).

Table 1 exhibits each case and the procedures performed. Cases 3 and 9 underwent a 1st MTPJ fusion and a Lapidus arthrodesis in conjunction with a PIPJ arthrodesis, respectively, and were placed in a below-the-knee cast for 6-8 weeks, and instructed to NWB with the assistance of crutches, knee walker, or wheelchair. For the remaining cases, patients were placed in a surgical shoe and were permitted to partial weight bearing status. In each case, X-rays taken at the 3-4 month follow-up period began to show signs of resorption into the patient's bone. By 12 months the implant utilized was fully resorbed and incorporated into each patient's bone(s).

Cases	PIPJ Fusion	1 st MTPJ Fusion	Lapidus Arthrodesis	Weil Osteotomy	1 st Metatarsal Osteotomy
A	xx				x
B	x			x	
C	x	x		x	
D	x			x	
E	x				
F	xx				
G	xx				
H	x				
I	x		x	x	
J	xxx				

Table 1. Cases reviewed with procedures listed. x = number of procedures performed

Results (continued)



Figures 4a-f. a. 1 week s/p. b. 2 weeks s/p. c. 1 month s/p. d. 3 months s/p. e. 6 months s/p. f. 12 months s/p.

Analysis & Discussion

This study focused primarily on the clinical outcomes at least 12 months post-operative for patients receiving PIPJ fusions with allograft implants for the correction of painful, rigid hammertoe deformities. These patients either underwent an isolated procedure of just 1 digit with allograft, or had it performed in combination with other procedures of the forefoot. We acknowledge that this is a retrospective case series, and so were unable to employ the use of AOFAS. This coupled with our small patient cohort size represent limitations to our study. However, we believe our consistent successful results demonstrate that allograft implants are a viable alternative fixation method for PIPJ arthrodesis.

Our results are consistent with other studies analyzing the success of allograft implants. Dr. Stephen J. Miller demonstrated successful fusion in 25 of 26 toes, but noted hardware failure in 2 toes, one resulting in a non-union requiring revisional surgery⁴. Another study by by Kominsky et al showed a 97% fusion rate with signs of bony consolidation at 14 weeks in PIPJ arthrodesis on 63 toes in 32 patients⁵.

There have been several other studies conducted comparing the efficacy of other fixation methods, such as intramedullary implants, bio-absorbable pins and cannulated screws, to K-wire fixation. A study by Angirasa et al. reviewed the SmartToe® implant and compared it to K-wire fixation, and found the SmartToe® group returned to full activity sooner and reported no complications. Radiographic unions were noted in 100% of these patients⁶. At this time, there are no studies comparing fusion rates between allograft implants and traditional K-wire fixation, and future studies should address this.

The high success rate of fusions observed our case series indicates that allograft implants can serve as an alternative method for PIPJ arthrodesis and are comparable to K-wire fixation.

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