

# Incidence of Nonunion of the First Metatarsophalangeal Joint Arthrodesis After Failed Implant Arthroplasty: A Systematic Review

Matthew Wilson, DPM, Anson Chu, DPM, Eric So, DPM, John Thompson, DPM, Mark A. Prissel, DPM, FACFAS

Orthopedic Foot and Ankle Center | Columbus, OH | 614-895-8747 | [www.orthofootankle.com](http://www.orthofootankle.com)

## INTRODUCTION:

First metatarsophalangeal (MTP) joint implant arthroplasty is a viable treatment option for arthritis and deformity correction while also retaining joint motion. (1) Indications for the procedure include: hallux rigidus, hallux valgus with arthritis, geriatric bunion deformity, and iatrogenic or traumatic induced hallux MTP joint arthritis. (2) When compared to arthrodesis, first MTP joint arthroplasty has a higher incidence of complications and hardware. (5) Etiologies for various implant type failures include: foreign body synovitis, peri-prosthetic osteolysis, implant malalignment, and implant fracture, with the literature exhibiting revision rates ranging 5-74%. (5-14) Few studies exist that evaluate the success of first MTP joint arthrodesis following failed implant arthroplasty. The purpose of this systematic review is to investigate the fusion rates of 1st MTP joint arthrodesis after conversion from implant arthroplasty.

## MATERIALS AND METHODS:

A systematic review of electronic databases containing articles involving first MTP arthroplasty or arthrodesis was performed. Three electronic databases (Cochrane, Pubmed, OvidSP Medline) were searched in June 2018. The systematic review was performed using the inclusive text word query "hallux" OR "great toe" OR "metatarsophalangeal" OR "metatarsophalangeal" AND "arthrodesis" OR "fusion" OR "arthroplasty" OR "replacement" OR "McKeever" OR "silastic" OR "Swanson" OR "implant" OR "union" OR "nonunion", where the uppercase words represent Boolean operators. There was no restriction placed on date, while only articles published in English were included. All manuscripts were reviewed and manuscripts were included with unanimous agreement amongst investigators. Inclusion criteria required studies including patient undergoing first MTP arthrodesis as a revision for failed implant arthroplasty with a mean follow-up of six weeks and detail regarding complications, nonunion rates, and patient demographics. Case reports, studies involving salvage of polyvinyl alcohol hemiarthroplasty, and articles with less than 5 reported cases were excluded.

Nonunion rate according to fixation type	
	Nonunion rate by fixation (%)
Screw only	2/13 (15.4)
Lag screw + plate	6/28 (21.4)
Plate	1/23 (4.3)
Steinmann pin	1/7 (14.3)
Nonunion rate according to bone graft type	
	Nonunion rate by graft type (%)
No graft	0/1 (0)
Morselized metatarsal heads	0/8 (0)
Tricortical iliac crest autograft	8/40 (20.0)
Femoral head allograft	0/2 (0)
Distal tibia autograft	1/2 (50.0)
Iliac crest allograft	1/1 (100)
Calcaneus autograft	1/23 (4.3)

Table 2- Nonunion rate according to fixation type

Author (year) [EBM]	Total Patients	Feet (N)	Mean Age (yr)	Type of Fixation	Bone Graft	Type of Implant	Follow-up (mo) [range]	Nonunion Rate (%)	Complications (%)	Revisions (%)	Average time to fusion (weeks)	Average interval time to revision surgery (mo)
Hecht 1997 [IV]	14	16	54	(10) screw + plate, (6) steinmann pin	(5) morselized met heads, (7) iliac crest autograft, (4) n/a	(16) silicone	55 [36-94]	12.5	31.3	6.3	10.4	38.0
Brodsky 2000 [IV]	8	8	57	n/a	(8) iliac crest autograft	(1) total surface replacement, (7) silicone	n/a [Min. 5]	12.5	37.5	0	13.1	n/a
Myerson 2000 [IV]	13	13	48	(6) screw, (6) lag screw + plate, (1) steinmann pin	(10) iliac crest autograft, (2) femoral head allograft, (1) distal tibia autograft	(11) silastic, (2) total replacement	62.5 [28-96]	38.5	53.8	23.1	12.9	30.2
Garras 2013 [IV]	18	18	56.2	(7) screw, (11) plate	(6) iliac crest autograft, (1) distal tibia autograft, (1) calcaneal autograft	(18) metallic hemi	51.6 [14-141]	0	11.1	0	12.1	46.8
Gross 2013 [IV]	11	12	56.9	(12) lag screw + plate	(1) no graft, (4) morselized met heads, (5) iliac crest autograft, (1) iliac crest allograft	(7) total silicone, (3) metal-backed silicone, (2) hemi	33 [4-144]	16.7	58.3	8.3	19.9	80.0
Usuelli 2017 [IV]	12	12	58.4	(12) plate	(12) calcaneal autograft	n/a	33.4 [12-64]	25.0	50.0	8.3	11.0	15.0
<b>Total</b>	<b>76</b>	<b>79</b>	<b>54.9</b>				<b>48.1</b>	<b>16.5</b>	<b>38.0</b>	<b>7.6</b>	<b>13.0</b>	<b>42.0</b>

Table 1- Demographic Data included in Systematic Review

## RESULTS:

The search for potentially eligible information for inclusion in the systematic review yielded a total of 3,691 manuscripts. All references identified were obtained and reviewed by each investigator in July 2018. After considering all the potentially eligible references, six (0.16%) met our inclusion criteria. All included studies were retrospective case series. (1,8-10,18,19) A total of 79 feet in 76 patients with a weighted mean age of 54.9, were included (Table 1). The most common indication for first MTP implant arthroplasty revision to arthrodesis was persistent pain in 86.1% (n=68/79), followed by aseptic implant loosening in 16.3% (n=8/49) and infection or septic implant loosening in 7.6% (n=6/79). Of the studies that reported interval time between the primary implant arthroplasty procedure and the revision arthrodesis procedure, the average duration was 42.0 months (Table 1).

Of the six included articles, radiographically confirmed nonunion rate was 16.5% (n=13/79) at a weighted mean follow-up of 48.1 months (Table 1). The average time to fusion was 13.0 weeks. (Table 1) The revision rate for nonunion was 7.6% (n=6/79) (Table 1). The overall complication rate across all included studies was 38.0% (n=30/79). (Table 3) Hardware complications were the most common complication other than nonunion at 10.1% (n=8/79), followed by wound dehiscence at 6.3% (n=5/79) and superficial infection at 5.1% (n=4/79). (Table 3) The incidence of unplanned surgical removal of hardware occurred was 10.1% (n=8/79) (Table 3). The overall incidence of reoperation was 15.2% (n=12/79). (Table 3) There was a wide variety of bone graft types used, with iliac crest autograft most common at 48.0% (n=36/75), followed by calcaneal autograft at 30.7% (n=23/75) and morselized resected metatarsal heads at 12.0% (n=9/75). (Table 1) Of the six included studies, two reported the size of bone block used to fill bone deficits with the average size of the bone block being 18.6mm. (18,19) The most common form of fixation that led to nonunion was combined screw and plate fixation with a nonunion rate of 21.4% (n=6/28) (Table 2). The most common bone grafting technique that led to nonunion was tricortical iliac crest autograft with a nonunion rate of 20.0% (n=8/40) (Table 2).

The methodological quality of the included studies was generally poor. All included studies provided level IV evidence (Table 1). There was heterogeneity in study type, fixation technique, indications for surgery, and study size among the included studies (Table 1).

Author (year) [EBM]	Dehiscence (%)	Superficial Infection (%)	Hardware Complications (%)	Nonunion (%)	Reoperation Rate (%)	Revision Rate (%)	Hardware removal rate (%)
Hecht 1997 [IV]	0/16 (0)	0/16 (0)	2/16 (12.5)	2/16 (12.5)	3/16 (18.8)	1/16 (6.3)	2/10 (20)
Brodsky 2000 [IV]	0/8 (0)	1/8 (12.5)	1/8 (12.5)	1/8 (12.5)	2/8 (25)	0/8 (0)	1/8 (12.5)
Myerson 2000 [IV]	0/13 (0)	2/13 (15.4)	0/13 (0)	5/13 (38.5)	0/13 (0)	3/13 (23.1)	0/13 (0)
Garras 2013 [IV]	2/18 (11.1)	0/18 (0)	0/18 (0)	0/18 (0)	0/18 (0)	0/18 (0)	0/18 (0)
Gross 2013 [IV]	2/12 (16.7)	0/12 (0)	3/12 (25)	2/12 (16.7)	5/12 (41.7)	1/12 (8.3)	3/12 (25)
Usuelli 2017 [IV]	1/12 (8.3)	1/12 (8.3)	2/12 (16.7)	3/12 (25)	2/12 (16.7)	1/12 (8.3)	2/12 (16.7)
<b>Total</b>	<b>5/79 (6.3)</b>	<b>4/79 (5.1)</b>	<b>8/79 (10.1)</b>	<b>13/79 (16.5)</b>	<b>12/79 (15.2)</b>	<b>6/79 (7.6)</b>	<b>8/79 (10.1)</b>

Table 3- Complication and Reoperation Rate

## DISCUSSION:

The purpose of the present systematic review was to evaluate the incidence of nonunion of first MTP joint arthrodesis as a salvage procedure for failed implant arthroplasty. Six studies were identified that met the inclusion criteria. (1,8-10,18,19) The incidence of non-union is 16.5% at a weighted mean follow-up of 48.1 months. The weighted mean time to union was 13.0 weeks.

Our pooled results demonstrate that first MTP joint arthrodesis remains a useful salvage procedure to manage failed implant arthroplasty with unavoidable nonunion and complication rates. Resultant to the significant nonunion rate for this salvage procedure, proper patient counseling of risks, benefits, complications, and potential outcomes is paramount prior to performing both the index first MTP implant arthroplasty and the revision procedure. Further research is warranted, including methodologically sound, appropriately powered prospective cohort studies focusing on long-term outcomes comparing joint preparation techniques and fixation constructs. Beyond the need for standardized patient reported outcomes, additional outcome measures should include union rates, functional assessment, complications and cost-benefit analysis. The evidence in the current literature precludes strong recommendations with regard any singular fixation construct, bone graft type, or surgical technique.

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