

Radiographic Outcomes of Nitinol Compression Staple Constructs for First Tarsometatarsal Joint Arthrodesis

Adam Buffington, DPM AACFAS; Patrick McEaney, DPM FACFAS; Douglas Pacaccio, DPM, FACFAS
Northwest Illinois Foot and Ankle Foundation Fellowship Sycamore, IL

Statement of Purpose

The purpose of this study was to determine the radiographic union rate after first tarsometatarsal joint arthrodesis using a new generation of nitinol staples and to compare outcomes between a nitinol staple construct and a nitinol staple with staple-plate construct and compare to previous published nonunion rates in the literature. We hypothesized that the nitinol staple constructs would have union rates comparable to previously published in the literature, and that the addition of a nitinol staple with plate would not significantly increase the arthrodesis rate.

Methodology

A retrospective chart review was performed to identify consecutive patients who underwent first tarsometatarsal joint arthrodesis using a new generation of nitinol compression staples or with a plate with nitinol staple construct with a minimum 3-month radiographic follow-up. Nonunion was defined as pain and swelling at the surgical site with no radiographic signs of osseous healing at the third postoperative month. Other patient demographics inspected included complications (other than failure to achieve fusion), BMI, smoking status, and diabetes. Patients underwent first tarsometatarsal joint arthrodesis with either a two staple “delta” construct (Fig. 1) or a medial staple non-locking plate with dorsal staple (Fig. 2).

The primary outcome variable was radiographic evidence of arthrodesis on radiographs in patients who underwent first tarsometatarsal arthrodesis. A total of 57 patients (62 joints) were eligible for analysis. Mean radiographic follow-up was 10 months and mean clinical follow-up was 13 months.

Literature Review

Multiple accepted methods are available to fixate the first TMT arthrodesis, such as crossing screws, plate and screws, parallel screws, and monorail external fixators (1–8). Most of these have been well studied within medical reports in terms of stability, pullout strength, and compression. These studies have also revealed the incidence of nonunion to range from 0% to 12% of cases. However, there are only a few reports in the foot and ankle literature for nonunion rates of staple fixation for first tarsometatarsal joint arthrodesis. Mallette et al reported an 8.3% nonunion rate utilizing a two staple delta construct in their study. Similarly, Schipper et al demonstrated a 91.7% fusion rate of 1st tarsometatarsal joint arthrodesis with staple fixation.

Level of Evidence

Level 3, Retrospective comparative cohort

Staple Constructs



Fig. 1
Delta Staple Construct



Fig. 2
Plate and Staple Construct



Results

Radiographic union was seen in 92.5% (37/40) of joints using the nitinol staple construct and 90.9% (20/22) of joints using the nitinol combined staple and plate construct. There was no significant difference in radiographic union rate between the 2 groups. Five patients developed nonunion, 3 in the staple construct group and 2 in the staple with plate construct group. None of the potential risk factors statistically significantly increased the likelihood of developing a complication (Table 2). All patients were full weightbearing at an average of 4.7 weeks (3-6 weeks).

All patients with union were nontender at the arthrodesis site and weight bearing with minimal or no pain at final follow-up. There was no significant difference in the rate of nonunion or need for revision arthrodesis between patient in each group. There were no deep infections in either group.

Table 1. Procedure Characteristics

Procedure Characteristics	Overall		Delta Staple Construct		Plate and Staple Construct	
	Joints, n	Radiographic Union, n	Joints, n	Radiographic Union, n	Joints, n	Radiographic Union, n
First TMT Joint Arthrodesis	62	57	40	37	22	20
		91.9		92.5		90.9

Abbreviations: TMT, Tarsometatarsal

Table 2. Patient Demographics

Patient Characteristics	Overall	Group		P Value
		Staple	Plate + Staple	
Patients, n (%)	62	40	22	-
Age, y				
Median	60	60	60	.37
Mean	56	56	55	
Range	13 - 83	13-83	17-68	
Sex, n (%)				
Male	9	3	6	.74
Female	53	37	16	
Smoker, n (%)				
No	48 (77)	30 (75)	18 (82)	.35
Yes	14 (23)	10 (25)	4 (18)	
BMI				
Median	26	26	26	.33
Mean	27	27	27	
Range	19 - 40	19 - 40	19 - 37	
Diabetes, n (%)				
No	59 (95)	38 (95)	21	.55
Yes	3 (5)	2 (5)	1	
Radiographic follow-up, mo				
Median	7	6	7	
Mean	10	10	4	
Range	3 - 46	3 - 46	3 - 17	
Clinical follow-up, mo				
Median	9	10	8	
Mean	13	13	11	
Range	3 - 46	3 - 46	3 - 29	

Abbreviations: BMI, body mass index

Discussion

The presented fusion rates are similar to those reported in the literature. Both constructs were safe and effective for use in arthrodesis of the first tarsometatarsal joint. Advantages of the new generation of nitinol staples are dynamic continuous compression that increases after time zero, full recovery of plantar gapping, and new delivery instrumentation that does not require refrigeration or heating of the staple. This study found that the staples have a high union rate, comparable to other constructs reported in the literature.

New-generation nitinol staples were safe and effective for first tarsometatarsal joint arthrodesis, with a high radiographic union rate. There was no statistical difference between the nitinol staple and nitinol staple with plate constructs.

References

- Saxena A, Nguyen A, Nelsen E. Lapidus bunionectomy: early evaluation of crossed lag screws versus locking plate with plantar lag screw. *J Foot Ankle Surg* 48:170-179, 2009.
- Coetzee JC, Wickum D. The Lapidus procedure: a prospective cohort outcome study. *Foot Ankle Int* 25:526-531, 2004.
- Treadwell J. Rail external fixation for stabilization of CBWO and Lapidus procedures: a retrospective analysis of sixteen cases. *J Foot Ankle Surg* 44:429-536, 2005.
- Myerson M, Allon S, McGarvey W. Metatarsocuneiform arthrodesis for management of hallux valgus and metatarsus primus varus, 1992 for management of hallux valgus and metatarsus primus varus. *Foot Ankle Int* 13:107-115, 1992.
- Patel S, Ford L, Etcheverry J, Rush S, Hamilton G. Modified Lapidus arthrodesis: rate of nonunion in 227 cases. *J Foot Ankle Surg* 43:37-42, 2004.
- Sangeorzan BJ, Hansen ST Jr. Modified Lapidus procedure for hallux valgus. *Foot Ankle Int* 9:262-266, 1989.
- Bednarz PA, Manoli A II. Modified Lapidus procedure for the treatment of hypermobile hallux valgus. *Foot Ankle Int* 21:816-821, 2000.
- Grace D, Delmonte R, Catanzariti AR, Hofbauer M. Modified Lapidus arthrodesis for adolescent hallux abducto valgus. *J Foot Ankle Surg* 38:8-13, 1999.
- Mallette GP, Glenn CL, Glod DJ. The Incidence of Nonunion after Lapidus Arthrodesis Using Staple Fixation. *J Foot Ankle Surg* 53:303-306, 2014.
- Schipper ON, Ford SE, Moody PW, Van Doren B, Ellington JK. Radiographic Results of Nitinol Compression Staples for Midfoot and Hindfoot Arthrodeses. *Foot Ankle Int* 39:172-179, 2018.
- Russell NA, Regazzola G, Aiyer A, et al. Evaluation of nitinol staples for the Lapidus arthrodesis in a reproducible biomechanical model. *Front Surg*. 2015;2:65.

For additional information please contact:

Adam J. Buffington, DPM AACFAS

Drbuffington@illinoisfoot.com