A New Approach to Problematic Joint Fusions of the Midfoot

BRYAN D. DEN HARTOG, M.D. • LINDSAY M. ORTLIP, PA-C

ABSTRACT

Purpose: One of the unresolved problems for foot and ankle surgeons is improving fusion rates of specific joints in the midfoot, specifically the talonavicular (TN), naviculocuneiform (NC), and 2nd and 3rd tarsometatarsal (TMT) joints. These joints are more difficult to fuse because of their relatively small size, high mechanical stresses and limited blood flow. For these reasons, non-union remains a relevant clinical challenge to the orthopaedic surgeon.

Methods: We performed 16 fusions in 16 patients between December 2017 and May 2019 utilizing a plate and clip construct. A retrospective review was conducted of 10 isolated TN fusions and 6 isolated NC joint fusions. The patients were followed to documented fusion by either weight-bearing CT scan or weight-bearing x-rays. Successful fusion was defined as 50% or greater trabecular connection between the fusion surfaces.

Results: 100% of the 16 patients had a successful fusion. A successful fusion was defined as 50% or greater trabecular connection between the fusion surfaces observed on weight-bearing CT scan or weight-bearing radiographs. For the 10 TN joints, the mean time to successful fusion was 10.3 weeks (range, 8-12 weeks) postoperatively. The mean time to fusion for the 6 NC joints was 10 weeks (range, 8-12 weeks) postoperatively.

Conclusion: For midfoot fusions, the use of the Active Stabilization® Technology plate and clip construct with its continuous compression and enhanced stability led to high union rates and good-to-excellent overall outcomes in the short term and midterm. This is promising technology for midfoot fusions.

INTRODUCTION

Despite the improvement in rigid fixation for foot and ankle joint fusions, there are still midfoot joints talonavicular (TN), Navicular-Cuneiform (NC) and 2nd and 3rd Tarsal-Metatarsal (TMT) that are difficult to get consistently high fusion rates. This is especially true if these problematic joint fusions are performed in isolation.

There are many factors involved in obtaining successful midfoot fusions including: patient selection, ability to heal, compliance with weight bearing restrictions, fusion preparation, and method of internal fixation. One of the key factors within our control is the method of fixation. Currently, most surgeons are utilizing internal fixation with a cannulated lag screw and compression plates. However, those constructs fail to provide continuous compression at the fusion site. A few surgeons have been using staples with Nitinol technology to improve the compression at the fusion site. Despite the improved geometry of recently designed staples, many surgeons are concerned that the Nitinol staples alone do not provide enough rotational and bending stability. More recently, Active Stabilization® Technology (CrossRoads Extremity Systems®, Memphis, TN) was designed to combine the stability of the plate with the continuous compression of the Nitinol clip in fusions. This paper reports an early experience with isolated TN and NC joint fusion rates using the Active Stabilization® Nitinol clip and plate construct (Figure 1).
METHODS

A retrospective review was conducted of 10 isolated TN fusions and 6 isolated NC joint fusions with a Nitinol clip and plate construct between December 2017 and May 2019.

The pre-operative diagnoses in the 10 TN fusions included 7 patients for posterior tibial tendon insufficiency with stage IIB flatfoot deformities (1 also had stage IIA flat foot deformity) and 3 were for isolated osteoarthritis of the TN joint. The pre-operative diagnoses in the 6 NC joint fusions included 4 patients with osteoarthritis of the NC joint or other midfoot arthritis; 1 was an attempted repair of prior non-union of the NC joint; and 1 had posterior tibial tendon insufficiency stage IIB with apex instability at the NC joint. The patients were followed to documented fusion by either weight bearing CT scan or weight bearing x-rays. The average follow-up was 16 weeks (range 12-32 weeks) for isolated TN fusions, and 14 weeks (range 10-22 weeks) for NC joint fusions. Successful clinical fusion was defined as 50% or greater trabecular connection between the fusion surfaces.

All of the joint surfaces were prepared with the combination of a high-speed burr to remove the cartilage and a drill to create multiple holes to expose cancellous bone. Positioning of the joint surfaces with deformity correction was performed and fixed with a lag screw. The titanium Z-plate and Nitinol clip combination (CrossRoads Extremity Systems®) was utilized.(Figure 1).

Patients were placed in a Robert-Jones splint and were instructed to remain toe-touch weight bearing (TTWB) for 2 weeks. After 2 weeks, post-operative patients were placed into a tall CAM boot and instructed to continue TTWB. Plain x-rays were taken at 2 weeks, 6 weeks, and 10 weeks post-operatively. (Figures 2A, 2B). A weight bearing CT scan was performed between 10 and 12 weeks post-operatively in 5 of the TN joint fusions (Figure 3A and 3B) and 3 of the NC joint fusions. The patients were allowed to fully weight bear when x-rays or CT scan showed 50% or greater healing (identifiable trabecularization across the fusion site). Average time patients began to fully weight bear in their CAM boot was 7 weeks post operatively.

RESULTS

Of the 16 procedures, successful clinical fusion was achieved in 16 of the 16 joints. 100% of patient had a successful clinic fusion which was determined by radiographic or CT evidence of 50% or greater trabecularization between the fusion surfaces. For the TN joints, the time to fusion averaged 10.3 weeks (range 8-12 weeks). The time to successful clinical fusion averaged 10 weeks for NC fusion with a range of 8-12 weeks.

No wound related complications or infections were observed. No revision arthrodesis procedures were performed.
DISCUSSION

The isolated fusion of the Talonavicular and Naviculocuneiform joints in the midfoot can be difficult to achieve given the small surface area of the joints and the large amount of stress placed upon these joints in the post-operative period. Historic non-union rates range from 6-25% (1-5). Traditional fixation with plates and screws have demonstrated that after 2-4 post-operative weeks, pressure necrosis leads to some loss of compression, thus potentially decreasing the stability at the fusion site. The advantage of Active Stabilization® technology is that the combination of the plate for stability and the continuous compression of the Nitinol staple has the potential to compensate for the loss of bone from pressure necrosis and theoretically providing a continued healing environment for osteogenesis.

This short-term follow up in a small cohort of patients suggests that the fusion rates are significantly better with the Active Stabilization® Technology using a Nitinol clip and plate construct. The accuracy of determining fusion in this patient group is reliable given that 7 of the 16 patients had WB CT scans between 10 and 12 weeks post-operatively. Additionally, the patients with plain x-ray evaluation and no CT scan were followed for least at 3.5 months (Figure 4A & 4B).

Further investigation is needed to evaluate for deformity correction and functional improvement in this patient group, which is a part of our ongoing study. The purpose of this study is to show the early results of a newer fixation method for these two difficult midfoot joint fusions. The early fusion results in this cohort indicate that the titanium plate and Nitinol staple construct improves the fusion rate in these challenging joint fusions.

CONCLUSIONS

The Active Stabilization® titanium plate and Nitinol clip product from CrossRoads Extremity Solutions appears to provide sustained stability and continuous compression at the TN and NC joint fusion sites. This produces high fusion rates in midfoot joints and should be confirmed with long-term follow-up and larger cohorts. Active Stabilization® Technology is promising.

Always refer to the package insert, product label and/or instructions for use before using any CrossRoads® Extremity Systems product.

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(901) 221-8406 | info@CRExtremity.com | CRExtremity.com