

Functional and Radiographic Outcomes in Rearfoot and Ankle Fusion Following Application With Advanced Bone Tissue Allograft

Dr. Robby Caballes, DPM PGY-II ¹, Dr. Kyle J. Kinmon, DPM ², FACFAS; Dr. Ashley L. Bowles, DPM ³, FACFAS; Dr. Julio J. Ortiz, DPM, FACFAS ⁴



¹ Second Year Resident Physician, Bethesda Health Foot and Ankle, Boynton Beach, FL; ² Residency Director, Bethesda Health Foot and Ankle Surgical Residency, Boynton Beach, FL; ³ Attending Foot and Ankle Surgeon, Bethesda Health Foot and Ankle, Boynton Beach, FL; ⁴ Attending Foot and Ankle Surgeon, Bethesda Health Foot and Ankle, Boynton Beach, FL

STATEMENT OF PURPOSE

Rearfoot/ankle fusions are implicated in end-stage arthritic and revisional/salvage surgery. Normal fusion times range from 8-10 weeks but may be prolonged in more complex cases. Return to normal activity is expected by 3-4 months; however, this may be hindered by complications (e.g. non-union). There has been recent interest in an advanced bone tissue allograft which aims to preserve the majority of endogenous growth factors originally present in bone. This new class of biologic contains Calcium Phosphate manipulated and retained in a resorptive Ca-deficient form. Its scaffold consists of biominerals, growth factors and predominant forms of collagen shown to accelerate fusion in literature cases of cervical spine fusion ⁽²⁾. This case series documents the functional and radiographic outcomes of rearfoot/ankle fusions following application with advanced bone tissue allograft.

METHODOLOGY

A retrospective study was performed on 16 patients (diabetic and non-diabetic) who underwent arthrodesis procedures of the rearfoot/ankle. The surgical procedures were performed by two surgeons, authors KK and AB, at Bethesda Hospital between April 2017 and August 2017. Of the 16 patients who were originally identified, 11 were included in the study after exclusion criteria. Inclusion criteria included the following:

- 1) Primary rearfoot/ankle arthrodesis (e.g. STJ, ankle, TTC)
- 2) Rearfoot/ankle revisional surgery
- 3) Serial post-operative film radiographs and CT scans
- 4) Follow-up of minimum 12 months post-operatively

5 of the 16 patients had undergone fusion procedures involving the forefoot and midfoot and were therefore excluded from the study. Of the remaining 11 patients, the rate of fusion was evaluated with serial X-rays and CTs post-operatively by the primary author/surgeons. Criteria involved at least 50% radiographic union shown by evidence of cortical bridging and/or osseous trabeculation across the fusion site. Surveys were performed - AOFAS, VAS, and NRS scores were obtained at pre-operative and final follow-up visits.

PROCEDURES

STJ fusion:

Incisional approach: a 6-cm curvilinear incision was made from the posterior aspect of the lateral malleolus to the level of the sinus tarsi. At that point, the sinus tarsi ligaments were transected and EDB muscle belly reflected. The STJ was then distracted and the contents were removed with a rongeur. The articular surfaces were resected down to bleeding cancellous bone and prepped for fusion with subchondral drilling (2.0 drill bit). At this time per intraoperative technique, the STJ was placed into anatomical orientation. Fixation was achieved utilizing either 6.5 mm or 7.0 mm cannulated screws. Intraoperative fluoroscopy was utilized to confirm positioning. At this time, the advanced bone tissue allograft was inserted into the fusion sites. Soft tissue closure was performed in layers utilizing a combination of sutures and/or staples.

Ankle fusion / Tibiototalcalcaneal fusion:

Incisional approach: a 6-cm incision was made over the lateral and anterior aspect of the ankle joint. For revisional surgeries, the involved hardware was removed and the ankle/STJ joints were re-evaluated. All soft tissues surrounding the joints were resected and the subsequent joints prepped for fusion with resection of non-viable bone and additional subchondral drilling (2.0 drill bit) down to bleeding cancellous bone. Per intraoperative technique, an intramedullary TTC nail was inserted from plantar to dorsal through the STJ and TTC joints. The nail was stabilized with 5.0 mm screws across calcaneus and tibia. Intraoperative fluoroscopy was utilized to confirm positioning. At this time, the advanced bone tissue allograft was inserted into the fusion sites. Soft tissue closure was performed in layers utilizing a combination of sutures and/or staples.

Revisional TAR with talar truss component:

One patient underwent revisional TAR with talar truss component and bone allograft incorporation.

LITERATURE

A retrospective review was performed by Dr. Robert Robinson on 125 patients undergoing anterior cervical decompression and fusion procedures between July 2016 and April 2017. Results were favorable in those with severe cervical degeneration. With these positive results, further research probed into its use in the foot and ankle in hopes of achieving similar results.

CONSIDERATIONS/PROTOCOL

If necessary, the following procedures were completed:

- 1) A drain was placed to prevent formation of a hematoma postoperatively.
- 2) A bone wedge allograft was inserted into the involved fusion site if significant deformity was noted.
- 3) Bone marrow aspirate was obtained from the calcaneus or tibia and utilized at the fusion sites.
- 4) A gastrocnemius recession was performed if an equinus deformity was present.

Postoperatively:

- 1) Patients were instructed to be non-weightbearing until fusion was achieved.
- 2) Patients followed-up weekly at which point interval plain film radiographs and CT scans were performed until bony fusion was noted.

RESULTS

Plain film radiographs and CT scans were performed on all patients pre- and post-operatively. Images were evaluated for radiographic signs of union as evidenced by osseous bridging or bony trabeculation across the involved joints. 9/11 patients (82%) showed radiographic union of at least 50% by four months and complete union by 1 year.

Two patients experienced subsequent revision surgeries -- one patient experienced iatrogenic non-union secondary to a traumatic altercation resulting in hardware failure. At final follow-up, the patient experienced no pain and related complete return to functional activity. The other patient resulted in non-union of the fusion site; however, related no pain with return to functional activity with the utilization of a CROW boot. Evaluation of the radiographs and CTs had shown well-alignment and stability of the TTC nail with no deviation of the hardware within the fusion sites.

Pre- and post-operative surveys were completed by both patient and physician. Mean NRS scores improved from 8 (pre-op) to 3 (post-op). Overall improvements occurred in AOFAS, VAS, and NRS scores with return to pre-operative functional levels of activity at final follow-up.

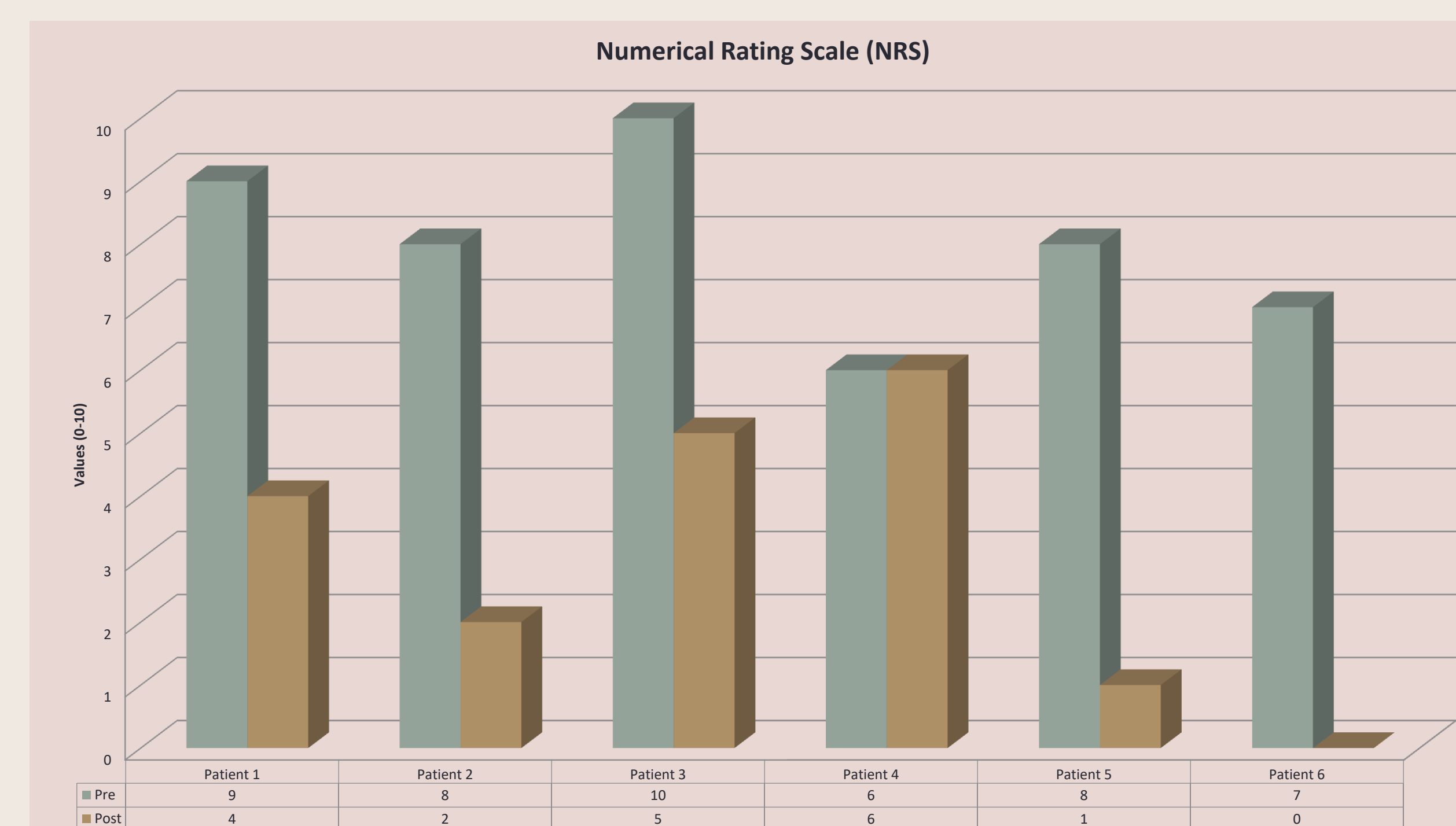


Figure 1: Numerical Rating Scale. 6/11 patients responded to surveys pre- and post-operatively with the overall pain level improving post-operatively following surgical intervention.

DISCUSSION & CONCLUSION

Currently, a multitude of bone tissue allograft substitutes are utilized in the surgical setting to potentiate joint fusion. The basis of this study was to evaluate the efficacy of the aforementioned advanced bone tissue allograft secondary to its retained growth factors and manipulated CaP properties which have been shown to accelerate fusion. Serial CT and radiographic imaging have shown favorable results in both the functional and radiographic outcomes of these patients. It must be noted however that even with correct technique and application of the bone tissue allograft, time-to-union may be prolonged based on the patient's comorbidities, social habits, and overall compliance post-operatively.

In conclusion, although higher level evidence studies are recommended, advanced bone tissue allograft may be worthy of consideration especially in those patients whom have failed previous attempts at primary fusion or revisional surgery with other bone allograft substitutes. This study has provided promising data on the acceleration of bone healing, time to union, and ultimate return of patients back to a functional lifestyle. Limitations included subjective evaluation of the imaging by the authors as well as a small sample size.



Image 1: LAT ankle plain film radiograph at 1 year follow-up showing bony fusion following triple AD including STJ fusion



Image 2: Sagittal ankle CT at 1 year post-op showing complete bony fusion at the STJ fusion site



Image 3: LAT ankle plain film radiograph at 1 year showing bony fusion following revisional TAR with talar truss implant



Image 4: Sagittal ankle CT scan at 1 year post-op showing fusion following revisional TAR with talar truss implant

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DISCLOSURES

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