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# 5 Year Outcomes of the “All-Inside” Arthroscopic Brostrom Repair in 66 Patients: A Retrospective Analysis

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## Purpose

The all-inside arthroscopic Brostrom procedure is a minimally invasive technique which is a viable option surgeons have to treat patients with chronic lateral ankle instability (CAI). Our hypothesis was that there will be a statistically significant difference in pre- and postoperative scores meaning the quality of the repair and patient satisfaction scores remained optimal at a minimum of 5 years post-operatively.

## Methodology

Pre-operative American Orthopedic Foot and Ankle (AOFAS) hindfoot scores, visual analog scale (VAS), foot function index (FFI) were compared with post-operative scores. Karlsson-Peterson (KP) scores were assessed at the final follow up. Unpaired t-tests were performed to determine if there was a difference in AOFAS, VAS and FFI scores.

## Demographics

Demographics	
# Patients (n)	66
Female	37 (56.1%)
Mean Age (years)	59.3
Laterality, L	31 (46.9%)
Mean BMI (kg/m <sup>2</sup> )	31.9

Table 1: Patient demographics

Score	Results	
	Pre-Op	5 Year Post-Op
AOFAS	51.8	88.9
FFI	83.5	18.4
VAS	7.36	2.24
KP	-----	73.6

## Results

Pre-operative scores were 51.8, 7.36, and 83.5, respectively. At the 5-year mark, the postoperative scores were 88.9, 2.24, 18.4 respectively and 73.6, for the Karlsson-Peterson scores. Furthermore, we compared those patients with a BMI < 30 kg/m<sup>2</sup> to those with a BMI ≥ 30 kg/m<sup>2</sup>. This comparison showed no significant difference between groups at 5 years.

## Analysis & Discussion

Lateral ankle sprains are one of the most common orthopedic injuries. If conservative therapy fails, surgical options include open vs arthroscopic repair. To our knowledge, this study is the first to investigate true “all-inside” lateral ankle ligament repairs without adjunct procedures.

Our data shows excellent long-term results in patients with chronic lateral ankle instability who underwent arthroscopic Brostrom procedure. This modified technique utilizes a push-lock anchor placed within the distal lateral fibula. Our study is limited due to low sample size, and retrospective nature. However, to the authors knowledge this is the first long term study that assesses strictly arthroscopic repairs without concomitant procedures. It would be prudent to perform prospective, randomized studies to further investigate the utility of the procedure. However, our results suggest that the arthroscopic Brostrom procedure is reproducible, reliable and demonstrates optimal satisfactory outcomes at a minimum 5 years postoperatively.



Fig.1: Surgical site markings including location of 4 sutures (green 1-4)



Fig.2: Arthroscopic view of anchors placed within the anterior face of the distal fibula



Fig.3: Four suture strands exiting respective sites after capture of the soft tissues using suture passer



Fig.4: Foot/ankle held in dorsiflexion and eversion while strands are hand tied. Hemostat used to gather the four strands through accessory incision on lateral fibula.



Fig.5: Push-lock is placed in distal lateral fibula above the level of the previously placed anchors

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# A New Human Placental Extracellular Matrix Particulate Supports Cell Infiltration: Therapeutic Potential for Complex Wounds

Heather Bara PhD, Sarah Moreno, Lisa Godwin, Shauna Clausen, Michelle Masee, Thomas J. Koob PhD, and John R. Harper PhD

ASPS, November 2022

## INTRODUCTION

Complex wounds arise from cellular insufficiencies that prevent progression through the healing cascade. Overcoming these challenges often requires a multifaceted approach, including application of advanced wound care products.<sup>1</sup> Collagen dressings are commonly used to facilitate cellular integration by providing a substrate for ingrowth and remodeling.<sup>2,3</sup> Efficacy of these dressings is dependent upon the source material and processing techniques. Placental extracellular matrix (PECM\*) particulate is a novel allograft, derived from human placental tissue and manufactured using a proprietary process which gently cleanses the tissue and removes cellular components. This study sought to characterize the composition of PECM and evaluate the effect of the tissue on cells using *in vitro* and *in vivo* tests.

## MATERIALS AND METHODS

**Immunohistochemistry:** PECM was hydrated, paraffin-embedded and 5 µm sections mounted to glass slides. Immunohistochemistry was performed with antibodies against human type I and type IV Collagens (Premier Laboratories). Images were acquired using a Leica DM86 Microscope.

**Collagen Assessment:** Total collagen was quantified using the QuickZyme Total Collagen Assay.

**Proteomic Characterization:** High pressure liquid chromatography and tandem mass spectrometry assessed the extracellular matrix protein composition of PECM (Creative Proteomics). Raw data was analyzed using Label Free Quantification in MaxQuant. Processing of the analyzed data was performed using Perseus. Identified protein groups with <1 unique peptide and with MaxQuant scores <10 were filtered out. Identified proteins were annotated to further identify which are known constituents of the human matrisome (matrisomeproject.mil.edu).

**PECM Extract Preparation:** Human placental tissue was processed in accordance with proprietary methods including cleansing, decellularization, dehydration, grinding, and terminal sterilization to manufacture PECM. The final product was rehydrated at a ratio of 10 mg/mL in Dulbecco's Modified Eagle Medium (DMEM) containing 0.5% Fetal Bovine Serum (FBS). Hydrated tissue was incubated at 37°C for 48 hours and the solids removed by centrifugation and passage through a 0.22 µm filter.

**Human Dermal Fibroblast (HDF) Migration Assay:** HDFs were plated on a clear 96-well ImageLock plate (Sartorius) at a concentration of 13,000 cells/well and incubated overnight at 37°C, 5% CO<sub>2</sub>. The monolayers were scratched using the 96-pin array, WoundMaker (Sartorius). Cellular debris was removed from the initial scratch with a series of rinses and treatments applied at the final concentration: 1, 2.5, 5, and 7.5 mg/mL PECM extract. Basal (DMEM with 0% FBS), 0.5% FBS DMEM, and complete media served as controls. Cellular migration was determined by live cell imaging for 120 hours with automated image processing to determine % Wound Confluence at each time point (S3 IncuCyte, Sartorius).

**In vivo mouse model:** Female and male NU/J atymic nude mice were implanted with 50 mg PECM into a 1 cm x 1 cm surgical pocket. Mice were euthanized at 1, 2, and 4 weeks post implantation. The implant sites were harvested on bloc with >10 mm tissue margins to include epidermis, dermis, muscle, and other surrounding soft tissues. Samples were fixed in 10% neutral buffered formalin for at least 1-2-24 hours, then transferred into 70% ethanol. Samples were paraffin-embedded and sections stained for Hematoxylin and Eosin (H&E). H&E slides were reviewed and scored by an independent histopathologist at StageBio.

**Immunofluorescence:** Immunofluorescence was performed on formalin-fixed paraffin-embedded sections. Briefly, sections were deparaffinized, subjected to antigen retrieval followed by blocking in Serum-Free Protein Block (Agilent Dako) for 1 hour at room temperature. Incubation with primary antibody against human-specific collagen type IV, mouse-specific collagen type I, and CD31 in Antibody Diluent (Agilent Dako) was carried out overnight at 4°C. For visualization, cells were incubated with Goat anti-Mouse IgG (H+L) Highly Cross-Adsorbed Secondary Antibody, Alexa Fluor™ 488 and Goat anti-Rabbit IgG (H+L) Highly Cross-Adsorbed Secondary Antibody, Alexa Fluor™ 647 (Thermo Fisher) and DAPI (Vector Laboratories) to identify the nuclei. Images were acquired on a Leica microscope fitted with 40X objective using Leica Application Suite Advance Fluorescence software and the THUNDER imager (Leica Microsystems).

## ACKNOWLEDGEMENTS

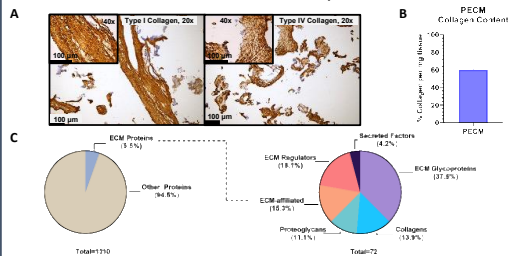
*In vivo* study conducted at Global Center for Medical Innovations (Atlanta, GA). Histological assessment was conducted by StageBio (Frederick, MD). Matthew Giedd (MIMED) provided proteomics analysis.

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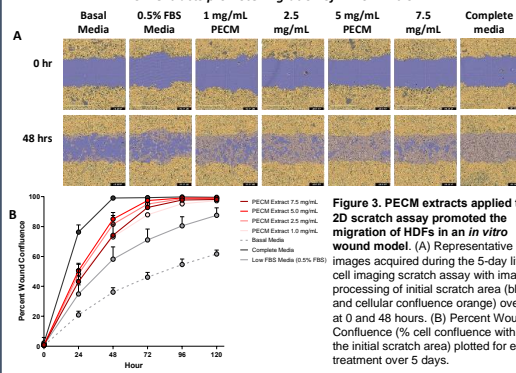
## RESULTS

### PECM composed of abundant human collagen and a large array of other extracellular matrix and ECM-associated proteins



**Figure 1.** Matrix Characterization (A) Distribution of Type I and Type IV collagen in PECM shown by IHC staining, 20x and 40x (insets); Scale = 100 µm. (B) (C) Proteomic analysis identified 1310 unique proteins present in PECM, 72 of which (5.5% of identified proteins) were further classified as extracellular matrix & matrix-associated proteins (left). ECM proteins were then further categorized (right). All percentages shown are of the total positive identifications across three PECM samples, not relative protein abundance.

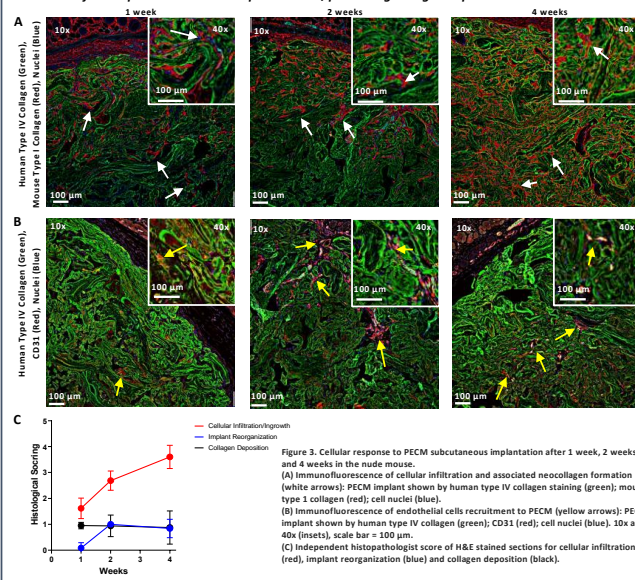
### PECM extracts promote migration of HDFs in vitro



**Figure 3.** PECM extracts applied to a 2D scratch assay promoted the migration of HDFs in an *in vitro* wound model. (A) Representative images acquired during the 5-day live cell imaging scratch assay with image processing of initial scratch area (blue) and cellular confluence orange) overlaid at 0 and 48 hours. (B) Percent Wound Confluence (% cell confluence within the initial scratch area) plotted for each treatment over 5 days.

## RESULTS

### Host cells infiltrate particulate PECM implant in vivo, promoting collagen deposition and neovascularization



**Figure 3.** Cellular response to PECM subcutaneous implantation after 1 week, 2 weeks, and 4 weeks in the nude mouse. (A) Immunofluorescence of cellular infiltration and associated neocollagen formation (white arrows): PECM implant shown by human type IV collagen staining (green); mouse type I collagen (red); cell nuclei (blue). (B) Immunofluorescence of endothelial cells recruitment to PECM (yellow arrows): PECM implant shown by human type IV collagen (green); CD31 (red); cell nuclei (blue). 10x and 40x (insets), scale bar = 100 µm. (C) Independent histopathologist score of H&E stained sections for cellular infiltration (red), implant reorganization (blue) and collagen deposition (black).

## CONCLUSION

PECM is a processed human placental tissue provided in particulate final form and intended for the replacement or supplementation of damaged or inadequate integumental tissue. The scaffold is permissive to infiltration by host cells, remodeling via deposition of neocollagen into implant voids, and endothelial cell recruitment, suggestive of neovascularization. These key features highlight the potential utility of PECM particulate to support the healing cascade and facilitate tissue repair in the management of large, complex wounds.

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All authors are employees of MIMED® Group, Inc.

BACK

### Purpose

The purpose of the study serves as a literature review and case study for a benign calcified cavernous hemangioma; rare in literature with few cases being reported.

### Procedure/Methods

A reverse "S" type incision was made. The skin and subcutaneous tissue was dissected free medial and lateral in full thickness flaps. The plantar fascia was divided and retracted along with the FDB. The calcified soft tissue mass was identified within the belly of the quadratus plantae and excised.



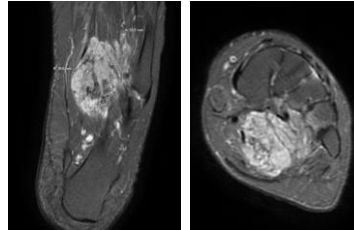
### Case Report

A 47-year-old Hispanic female with a 10 year history of left plantar foot pain. Presenting with worsening pain and swelling to the plantar left foot exacerbated by exercise.

Mild swelling and pain upon palpation were noted to the plantar aspect of the midfoot. A palpable non-mobile firm mass was appreciated along the medial longitudinal arch.

Radiographs demonstrated abnormal ossifications plantar to the cuboid and metatarsal bases. MRI was revealed a 5.3 cm x 3.6 cm x 3.4 cm heterogeneous hyperintense T2 lobulated enhancing mass with foci of mineralization. The patient decided on surgical management as she had exhausted all conservative treatment modalities including controlled ankle motion walker, orthotics, anti-inflammatory medication and compression.

The patient has been followed for greater than 12 months with complete resolution of symptoms.



### Results

The firm irregular mass measured 4.8 cm x 2.7 cm x 2.0 cm. The mass was morphologically consistent with a cavernous hemangioma with significant osseous formation. The histologic diagnosis was intraosseous cavernous hemangioma vs. ossified cavernous hemangioma.



### Analysis

Hemangiomas are a common benign and rarely malignant soft tissue tumor and primarily occur in the first three decades of life<sup>3,5</sup>. They usually incorporate larger vessels and can present subcutaneously, dermal, or intra-muscular<sup>1,3</sup>. Clinically are often associated with palpable mass which may be symptomatic or asymptomatic. Progressively enlarging mass with pain, swelling, tingling, burning and skin color changes. Pain and swelling are the most common symptoms, exacerbated by activity and dependent positioning<sup>2,3</sup>.

Radiographs, US, MRI, and CT can be utilized with MRI being the most helpful.

Treatment of choice has been wide surgical excision with low recurrence rate<sup>1-5</sup>.

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## Abstract

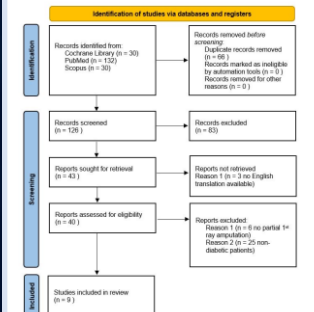
**Background:** The hallux is an essential component of a normal functioning gait. Largely partial first ray amputations are performed with little regard to the biomechanics of the foot, which may increase the rate of re-ulceration and re-amputation due to transfer pressures. In addition, partial first ray amputation failure can cause a significant financial strain on patients and the healthcare system. This study aims to conduct a systematic review of partial first ray amputations and propose a two-stage amputation with seven recommendations to prevent partial first ray amputation failure.

**Methods:** Three databases were used, which yielded 192 results, using diabetic patients and partial first ray amputation as the inclusion criteria. The exclusion criteria were trauma, burns, systematic reviews, and foreign languages. After eliminating non-eligible articles, nine were included in the study.

**Results:** Our analysis showed that from 1997 to 2021, the total amputation rate for 1226 patients was 27.24%. The level of further amputation for these patients was BKA (24.85%), TMA (21.26%), and lesser digit (4.34%).

**Conclusion:** Utilization of these biomechanical corrective recommendations is highly encouraged to produce a more balanced first ray amputation stump with a significantly lower failure rate. To our knowledge, this is the first systematic review for a partial first ray amputation. We proposed two stages of amputation with seven recommendations to prevent first ray amputation failures in the diabetic population.

## Methods



**Figure 1:** PRISMA diagram representing the identification of studies based on the inclusion criteria: diabetic patients and partial first ray amputation. Exclusion criteria: trauma, burns, systematic review, and foreign languages.

## Figures / Images

First Ray Amputation Level	Biomechanical Consideration	Biomechanical Corrective Recommendation
Partial Hallux Amputation	Check for equinus contracture	TAL/GR Must maintain 0.8 to 1 cm of the base of the proximal phalanx to prevent transfer lesion Tendons PHL to EHL Digital tendon balancing if pre-existing digital contractures Multi-density inserts/diabetic shoes
Partial Hallux Amputation with Hallux ridges	Increase pressure to the plantar hallux stump Limited ROM to the first MPJ Check for equinus contracture at the ankle	TAL/GR First MPJ arthroplasty Chalkenbury Digital tendon balancing if pre-existing digital contractures Multi-density inserts/diabetic shoes
Partial First Ray Amputation (disarticulation of the first MPJ)	Loss of windlass mechanism Collapse of the medial, lateral longitudinal arches Collapse of the distal and proximal transverse arches Charcot development Transfer lesion to lesser digits and rays Equinus contracture due to loss of the extensors (EHL/EHL) Digital contractures	TAL/GR Bone resection in the second quartile Level the cut medially and plantarly Monitor for Charcot clinically & with imaging studies (recommended MRI for early detection) PHL to EHL, tendons, TMR, ABR muscle flap Hammer toe correction via fusion, arthroplasty, tenotomies Multi-density inserts/diabetic shoes

**Figure 2:** Summary of the biomechanical recommendations for first ray amputation at the level of amputation, biomechanical consideration, and corrective recommendation



**Figure 3:** Diagram of a two-stage recommendation of a balanced amputation

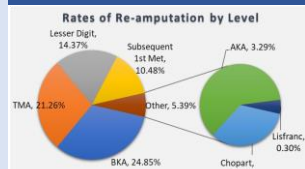


**Images:** A) 21-year female Type 1 DM patient with first ray partial amputation secondary to osteomyelitis without a balanced amputation B) Same patient 12 months S/P partial first ray amputation with subsequent neurotraumatic Charcot deformity C)  $\beta$  is the recommended location for partial first ray amputation associated with less re-ulceration.<sup>16</sup>

Recommendations To Prevent Partial First Ray Amputation Failure	
#1: Perform a Balanced Amputation	See Figure 2 and Figure 3.
#2: Monitor the Patient for Charcot	Evan et al. found that complete Charcot collapse of the foot and severe hindfoot pathology was the only identifiable risk factors that existed in the BKA population and not in the minor amputation group. <sup>15</sup>
#3: Institute a Multidisciplinary Approach	Mitsuzuka et al found that a multidisciplinary team approach reduced major amputation in 94% of studies. <sup>20</sup>
#4: Prevent Transfer Lesions/Abnormal Pressure	See biomechanical considerations and corrective considerations in Figure 3.
#5: Resect Bone in the Appropriate Cutting Planes	The first metatarsal should be beveled medially and plantarly.
#6: Resect Bone in the Second Quartile	Sanz-Corbalan et al. found that resection in the second quartile is associated with less re-ulceration (See Image C, labeled B). <sup>14</sup>
#7: Combine Extrinsic and Intrinsic Offloading	A combination of extrinsic and intrinsic offloading provides a better outcome as compared to relying on either/or method.

**Figure 4:** Seven important recommendations to prevent partial first ray amputation failure.

## Results



**Graph 1:** Subsequent levels of partial first ray amputation progression

## Discussion/Conclusion

Amputations affect the quality of life for the patient and their family and are often associated with higher mortality rates. This systematic review aimed to evaluate the biomechanical causes of first ray amputation failure and provide recommendations to alleviate this growing problem in the diabetic community. To fully understand the biomechanical implications after a first ray amputation, we must understand the anatomy of the first metatarsophalangeal joint (MPJ) and the importance of the proximal phalanx. The proximal phalanx is the attachment site for the extensor hallucis brevis, flexor hallucis brevis, abductor hallucis, adductor hallucis, and plantar plate. It is important to note that the plantar plate is the principal stabilizer of the MPJ, and helps block dorsal subluxation, cushions the joint, and provides supportive weight-bearing force. This highlights the anatomical importance of the base of the proximal phalanx to the first ray anatomical stability. The loss of the proximal phalanx, especially during partial first ray amputation, will lead to the loss of the windlass mechanism causing biomechanical instability to the first ray/medial column, which subsequently will lead to the collapse of the proximal and transverse arches and the lateral column. An example of this is depicted in Images A and B, a radiograph of a 21-year-old type 1 diabetic female with a partial first ray amputation secondary to osteomyelitis who returns one year later with a Charcot deformity. This is the reason why partial hallux amputation is favored because it preserves the windlass mechanism and the forefoot mechanics.<sup>17</sup>

Radiographic findings associated with partial first ray amputations were described by Poppen et al.<sup>18</sup> They found that on lateral radiographs, one can visualize a proximal migration of the sesamoids, plantarflexion of the first metatarsal when comparing it to the lesser metatarsals with 20-30 degrees of dorsiflexion of the second metatarsal, and decreased navicular height indicative of a collapsing medial longitudinal arch, and decreased cuboid height indicative of a collapsing lateral longitudinal arch. On anteroposterior (AP) radiographs, one can appreciate a medial drift of the second digit, decreased mineralization of the first metatarsal, the lateral drift of the sesamoids, and increased intermetatarsal (IM) angle. So, when considering a partial first ray amputation on patients, the practitioner, in conjunction with an imaging modality, needs to assess key biomechanical functions, including equinus contracture at the ankle, the range of motion at the first MPJ, hammering and claw deformity, retrograde force at the MPJ, plantarflexion of the metatarsal head, anterior displacement of the plantar fat pad, and callus formation prior to the operation.<sup>14,15,16,19</sup> Soft tissue and osseous balancing procedures should be considered to prevent partial first ray amputation failure, ranging from re-ulceration to Charcot.<sup>14,15,16,19</sup>

Our literature review found that following a partial first ray amputation, the most common subsequent amputation due to complications in diabetic patients is a BKA, followed by a TMA. Following the two-stage amputation model can prevent further complications and re-amputations. Stage one involves stabilization of the patient by removing any detrimental unstable soft tissue and bone, thereby destabilizing the foot biomechanics. Stage two entails prophylactic re-stabilization of the foot with soft tissue and osseous procedures to restore normal biomechanical function, yielding a balanced amputation. Also, not seven recommendations to prevent partial first ray amputation failure lays out the framework for providers to consider in preventing high failure rates as reported in the literature and the monetary burden on healthcare systems. Future retrospective or prospective studies must prove that these recommended corrective measures work. Additional studies are necessary to validate these recommendations, but our current research suggests it will save patients from further amputations.

## References





# Case Report: Pediatric Osteochondroma

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### Purpose

The purpose of this study is to investigate the excision of an osteochondral lesion on a pediatric patient and its effects.

### Case Study

The patient is a 17-year old athletic male who was initially seen for throbbing pain to the right hallux. The patient denied any trauma and stated he noticed a small area of discoloration form on his right hallux nail about a month prior to the visit. He stated it began as painless however now he felt pain at the tip of the toe and had noticed some redness and swelling. He states the pain is preventing him from playing basketball. The patient had tried taking 400 mg Ibuprofen, applying ice, and resting however nothing had alleviated the pain. Upon physical examination the right hallux appeared red and swollen, there was a dot of discoloration noted in the center of the hallux underneath the nail, and pain was noted upon palpation of the hallux. An x-ray of the right foot was obtained and displayed an area of bony growth at the distal tip of the distal phalanx of the hallux (Fig 1). At this time it was discussed with the patient and parent that although an area of exostosis is seen in the x-ray it is not consistent with the acute onset of right hallux inflammation and pain. The patient was diagnosed with a right hallux infection and prescribed antibiotics for 10 days. The patient was also instructed to monitor the spot of discoloration, and was told if the inflammation did not subside with the antibiotics then a nail debridement may be warranted at the next follow up visit in one week.

At the one week follow up appointment the patient reported significant decrease in pain to the right hallux and improvement in inflammation. The patient stated the pain had not completely subsided however he is able to perform his daily activities and play basketball. Treatment continued as a right hallux infection and the patient was instructed to take 5 more days of antibiotics and return as needed.

The patient then returned to the clinic 6 months later, again with a chief complaint of pain to the right hallux however this time the patient stated someone had stepped on his toe while playing basketball the day before. The patient stated it is painful to walk. He also noted that the area of discoloration underneath the hallux had also increased in size since his last visit. Physical examination did show a notable mass underneath the right hallux as well as pain upon palpation of the hallux. X-rays were obtained of the right foot and exhibited an increase in size of the osseous growth on the right hallux compared to 6 months prior (Figure 2). At this time, after discussion with the patient and parent surgical intervention was planned for excision of the mass.

### Surgical Procedure

A well padded ankle tourniquet was utilized to the right lower extremity. A local anesthetic digital block was performed to the right hallux utilizing 1% lidocaine plain and 0.5% marcaine plain. The procedure began with a total nail avulsion to the right hallux after which, the bony neoplasm was visualized and removed with a #15 blade. The specimen of bone was sent to pathology. The area was then debrided with a curette to ensure removal of the neoplasm in its entirety. Thorough irrigation was performed with normal saline to the incision site. Dry, sterile dressings were applied to the right hallux. Patient was discharged with a surgical shoe and was told to remain partial weight bearing to the right foot.

### Literature Review

An osteochondroma is found to be the most common benign bone tumor in the body<sup>1</sup>. They can occur in various sites throughout the body. Osteochondromas are typically found in adolescents and young adults<sup>2</sup>. Diagnosis is usually confirmed by radiographs or histologically and can allow differentiation into different kinds.

An extraskeletal osteochondroma is rare in that it does not have any osseous attachment. Extraskeletal osteochondromas are usually asymptomatic and grow at a slow pace, therefore they only become a problem when they begin to compress surrounding tissue structures. They are commonly found in adults between the third and sixth decade of life<sup>1</sup>.

Another kind of osteochondroma is subungual which is also a very rare form. The most common location it can be found in is the distal phalanx of the big toe but can also involve other phalanges of the hands and toes. Due to the position, it often causes damage to the nail plate. It occurs mainly in the second or third decade of life. A subungual osteochondroma differs from others by it has a cortical and medullary component that is continuous with the distal phalanx of the toe<sup>2</sup>. Dupuytren studied subungual osteochondromas back in 1847 however the exact etiology is still unknown, some believe it is caused by trauma, while others believe there may be a congenital component to it<sup>1</sup>. It is frequently misdiagnosed due to its similarity with subungual exostosis. The main difference can be seen histopathologically, a subungual osteochondroma contains a hyaline cartilage cap whereas a subungual exostosis has a fibrocartilage cap<sup>1</sup>.

Based off previous research the proper and most effective treatment of osteochondromas is total excision. Depending on the exact location the nail may be spared. If removed completely then recurrence is rare<sup>1</sup>.



Figure 1. Initial Radiographs



Figure 2. Post traumatic event, six month follow up, Pre-Op

### Discussion

The surgical procedure included a total nail avulsion followed by complete excision of the bony neoplasm. The specimen was sent for Pathology and the report concluded that the bony neoplasm was osteocartilaginous tissue consistent with osteochondroma with overlying hyperkeratotic skin, consistent with callous. The patient's radiographic images helped diagnose the bony neoplasm and allowed for sequential observation of the growth. The patient is currently six months post operative and has had no recurrence and is back to regular activities and athletic activities.

This case study illustrates the importance of reviewing radiographic imaging and monitoring the patient clinically for the proper diagnosis of osteochondromas. It can easily be misdiagnosed as an infection because it may present with erythema and inflammation as such. Through proper examination it can be determined whether surgical intervention is necessary, and if so at what point.



Figure 3. Clinical image Pre-Op



Figure 4. Clinical Intra-Op, bony neoplasm removal



Figure 5. Intra-Op complete neoplasm removal



Figure 6. Excised Bony lesion

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# Case Review: Treatment of Avascular Talar Neck Necrosis via Partial Talar Cadaveric Graft

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## BACKGROUND

Talar neck fractures account for less than 1% of bone injuries to the foot and ankle, although 50% of talar fractures occur at the neck of the talus as a result of forced dorsiflexion under a critical axial load.<sup>[1]</sup> Avascular necrosis (AVN) of the talus can develop from this injury due to soft-tissue detachment compromising blood supply. This interruption of arterial supply leads to tissue death, or necrosis, which manifests as a painful condition for the patient. Falls from great heights and automobile accidents are the two leading causes for talar neck fractures.<sup>[2]</sup>

While conservative treatment can be pursued by means of pharmaceutical regimen and supportive care, invasive maneuvers have served as a more effective approach when attempting to preserve the tibio-talar joint in the early stages of disease progression. Partial or total talar replacement has produced positive results such as, reducing the period the patient is immobile, restoring the mobility of the joints, and preserving the length of the limbs.<sup>[3]</sup> Many materials used for replacement could be alumina-ceramic or even 3D printed models of the talus. For this case review, a total talar replacement was performed using a remodeled cadaveric talus.

## PURPOSE

The purpose of this case review is to investigate the effectiveness of treatment of avascular necrosis of the talus through partial cadaveric graft. This treatment review will support the use of partial cadaveric bone grafts as a successful surgical intervention for talar neck necrosis.

## CASE PRESENTATION

The patient, a 43-year-old female, fractured her left talar neck in an auto accident ten years prior, necessitating closed reduction and external fixation. After 3 months of using a frame, the patient underwent 2 months of physical therapy. The patient developed complex regional pain syndrome and AVN of the talus. In order to correct this, a talar substitution using a remodeled cadaveric talus was performed.

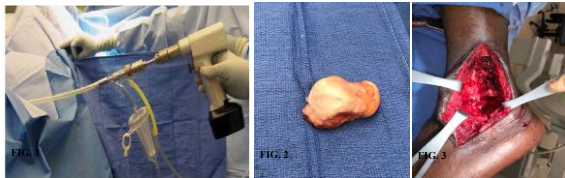


Fig. 1: RIA device (reamer irrigator aspirator) used for bone marrow harvesting

Fig. 2: Cadaveric Talus used for surgical graft

Fig. 3: Initial incision site with surgical recession, partially removed talus

After examining the patient and performing a full biomechanical evaluation, it was determined that the patient would need surgical intervention. While performing surgery, a decreased size of the talus was noted. Due to this finding, it was evident that the best access would be with a lateral approach via a fibular take down. The distal aspect of the tibia was removed up to 5 cm above the joint, following an incision in the lateral aspect of the tibia. The majority of the native talus was removed except for the talar head, which remained healthy according to imaging studies. A cadaveric talus was remodeled, and the cartilage was removed. The ankle and subtalar joints were prepared for a fusion. The graft was placed and temporarily fixated with a staple where the native talus previously stood.

The calcaneus, talus, and tibia were drilled and the bone marrow was collected using the RIA system (reamer irrigator aspirator). The bone marrow was applied to the subtalar and ankle joints. A tibio-talar-calcaneal fusion was then performed using a TCC nail, and all incisions were closed.

## RESULTS

The patient followed-up in the clinic on a weekly basis for 1 month. Sutures were removed at 4 weeks, splint was removed at 8 weeks, at which time the patient was placed in a CAM walker and was instructed to begin weight bearing. Physical therapy was also ordered at this time. Patient was seen every 2 weeks for 2 more visits and was successfully discharged free of pain. Patient was fully weight bearing and upright wearing sneakers at 12 weeks post-op. Patient has followed-up every 6 months since then and remains pain free to this day at 16 months post-op.

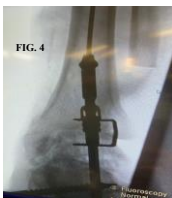


Figure 4. AP view of Tibio-Talar RIA bone marrow retrieval of left lower extremity

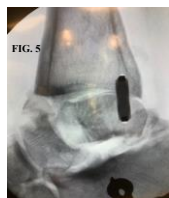


Figure 5. Lateral view of talus during temporary fixation of graft via staple

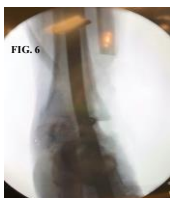


Figure 6. AP view of left ankle post TTC nail fixation of left ankle



Figure 7. Lateral view of ankle post TTC nail fusion of left ankle

\*The following images were taken chronologically during the surgical procedure

## DISCUSSION

An alternative material that was considered at the time was a 3D printed talus, however, research is available that concludes there are many issues still present with 3D printed technology. One key factor is that the internal structure of the printed talus has a regular pattern compared to the natural bone structure being irregular<sup>[9]</sup>. Therefore, a printed talus was not chosen due to the potential for compromise of surrounding structures and bone due to the inability of being able to support the patient's weight. The cadaveric graft was the optimal choice for this specific patient that ultimately yielded the best circumstances.

## CONCLUSION

Prior to surgical intervention, the patients quality of life was severely diminished due to her complex regional pain syndrome and AVN of the talus. The magnitude of pain was so great that it interfered with her ability to perform basic daily functions and her livelihood was suffering. Dr. Rosario-Aloma formulated a personally tailored plan resulting in successful post-op recovery, complete recession of pain and no related incident in the following 16 months. This review further supports surgical intervention and treatment of avascular talar necrosis through the use of a cadaveric graft and RIA as a viable option for future procedures.

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BACK

# CYCLICAL PRESSURIZED OXYGEN THERAPY DECREASES HOSPITALIZATION AND AMPUTATION RATES IN PATIENTS WITH DFU'S



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## PURPOSE:

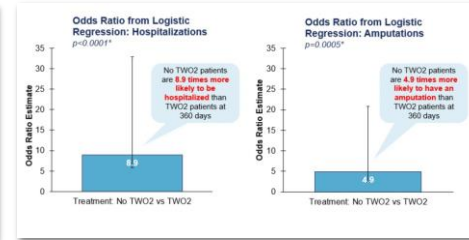
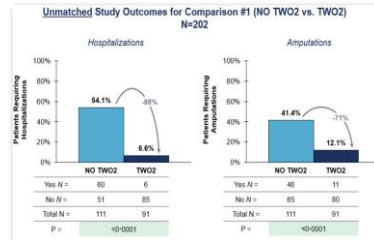
The use of Cyclical Pressurized Topical Oxygen Therapy now has the evidence needed to prove that it is a beneficial adjunct to the healing of Diabetic Foot Ulcers. Both in the form of Level 1A RCT's and Real-World Evidence Studies, as well as many favorable meta-analysis and reviews, this modality now is supported by better evidence than many other modalities already in use. If DFUs can now be healed faster, with fewer reoccurrences and at a lower cost, then this can be useful to both patient and payor alike.

## METHODS:

Using both RCT data and a multi-site study, using retrospective data, all data was collected from the clinical records of Diabetic foot ulcer patients. These patients were followed for at least one year. The main outcomes include wound closure, limited hospitalizations, and limited amputations as they relate to medical resource utilization and costs.

## RESULTS:

Significant differences are noted between the control group receiving good standard of care wound care and the group receiving both Cyclical Pressurized Topical Oxygen Therapy (TWO<sub>2</sub>) and good standard of care wound care.



## CONCLUSIONS:

The analysis indicates significant benefits attributable to using TWO<sub>2</sub> as compared to not using this treatment modality. There is a notable decrease in the economic burden of healing diabetic foot ulcers when TWO<sub>2</sub> is employed as part of the healing protocol. Monetary and economic modeling can demonstrate the significance of the application of this modality by several Payor systems.



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 Veterans Health Administration  
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### Disclosures:

MGG – Chief Medical Officer, AOTI  
 AL – Salem VA Medical Center



## Introduction/Purpose

The prevalence of tarsal tunnel syndrome (TTS) is believed by many authors to be underestimated due to the fact that oftentimes, it is underdiagnosed or occasionally misdiagnosed.

With open surgery, a common etiology of tarsal tunnel syndrome recurrence is scarring entrapment after surgery, especially in patients at high risk for scarring and keloid formation. For those populations and for those with a high risk of wound complications, we propose an endoscopic approach showing significantly less incidence of possible recurrence via scarring and wound complications.

## Methods

After diagnosis was confirmed by clinical exam, MRI, and EMG studies, five patients were selected. Four males and one female met the inclusion criteria. The average age of the patients was forty years old. None of the patients had bilateral pathology.

Inclusion criteria included idiopathic TTS with failed conservative treatment, custom-made orthoses, NSAIDs, steroid injections, and physical therapy. All etiologies of tarsal tunnel syndrome other than idiopathic etiology, such as metabolic and autoimmune diseases, space-occupying lesions, and more proximal nerve compressions (e.g. lumbar spine pathologies) were excluded.

None of the patients received any simultaneous surgery for any other possible contributory pathology (e.g. gastrocnemius lengthening, plantar fasciectomy, mass excision).

All patients underwent ultrasound-guided endoscopic posterior tarsal tunnel release surgery for tarsal tunnel syndrome. Follow up with visual analog scale used to determine procedure success. The minimum postoperative follow-up was six months.

## Financial Disclosure

None

## Procedures

All patients underwent the endoscopic tarsal tunnel release in the operating room, under general anesthesia and local block, with the use of a thigh tourniquet. The set of instruments used included a 15MHz Ultrasound device with linear transducer, Cannula, Trochar, 2.7 mm scope, and Hook Knife.

Using ultrasound, the posterior tibial artery was visualized, and landmarks were drawn. The flexor retinaculum was identified based on anatomic landmarks and ultrasound visualization. A 1.0 cm incision was made on the superior aspect of the retinaculum. Blunt dissection was used to get access underneath the flexor retinaculum. The retinaculum was palpated using the hemostat. A clear cannula with a blunt trochar was placed underneath the retinaculum and pushed inferiorly passed through the tissues until it tented up the skin at the inferior aspect of the flexor retinaculum, where another 1.0 cm incision was made. A 2.7mm scope was placed into the cannula to visualize all structures. The scope was rotated in the clear cannula to ensure no neurovascular structures were injured during the procedure. An endoscopic hook blade was then used to incise the flexor retinaculum. The scope was held at the superior aspect of the incision, and the hook blade was followed by the scope as it resected the retinaculum fibers.

Post-operatively, patients were immobilized in a CAM boot for 2 weeks and instructed to start ROM exercises 72 hours after the procedure to prevent perineural fibrosis and subsequent nerve entrapment. CAM boot was discontinued after 2 weeks, and an ankle brace was used for 4 weeks. The rehabilitation program started at the 2.5-week mark and consisted of electrical stimulation, cold therapy, ROM exercises, and gradually increasing passive stretching for 4 weeks, with additional 8 weeks of increased passive stretching, Graston technique, passive and active ROM exercises, balance exercises, and strength training.



Figure A: Intra-operative photo of portal placement. Figure B: Intact flexor retinaculum fibers. Figure C: Released flexor retinaculum fibers.

## Case Series

The five patients presented with classic symptoms, including tingling, burning, and heaviness in the sole of the foot with positive Tincl and Valleix signs, and were primarily diagnosed with tarsal tunnel syndrome via clinical exam, MRI, and EMG. The average visual analog scale (VAS) pre-operatively was 8/10.

A surgical option for reducing scarring postoperatively in the literature is the creation of a physical barrier from the nerve to the surrounding soft tissue (e.g., vein or collagen wraps). This option, however, does not resolve the issue of hypertrophic scarring of the skin. Endoscopic tarsal tunnel approach was the procedure of choice in this study as it requires minimal small incisions, avoiding excessive scarring and reducing the risk of recurrence due to post-operative scarring and adhesions.

## Analysis

A systematic review of endoscopic tarsal tunnel release has shown few complications: with only 1 in 37 procedures resulting in wound dehiscence (2.7%)<sup>2</sup>. With no cases resulting in hypertrophic or internal adhesion formation, surgeons can confidently perform tarsal tunnel release endoscopically without fear of those complications. However, the literature indicates the endoscopic approach has a steep learning curve, possibly leading to inadequate release to the novice surgeon.

Based on our analysis, we believe that the patient who did not show improvement after initial endoscopic surgery was due to severe, multilocal entrapment that necessitated open release.

## Results

Four of five patients had excellent results with complete relief of symptoms on physical exam and an average VAS score of 1.25 over the follow-up period of six months.

One patient had recurrent pain and a VAS score of six, necessitating open medial tunnel release along with any communicating fascia toward the flexor retinaculum, which relieved symptoms.

## Conclusion

The minimally invasive endoscopic procedure is a viable alternative approach for tarsal tunnel syndrome patients with a high risk of scarring or wound complications.

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### Background

Fish skin grafts (FSG) are increasingly being used for a wide range of wound repair. It's versatility is attributed to the fish skin's protein composition which closely resembles that of human skin, allowing for the graft to be used in a homologous manner to treat human skin. The graft's porous microstructure provides for efficient ingrowth of dermal cells and capillaries, further supporting the body's own ability to regenerate by recruiting the body's own cells (1)

Human and farm animal tissue require extensive processing and treatment with the harsh chemicals which dissolve components of the native tissues; this reduces it to a matrix of inactive collagen connective tissue only. Pathogen transmission risk from the Icelandic cod (*Gadus morhua*) to humans is nonexistent. This allows for minimal processing of the fish skin, preserving its native structure and chemical components. Specifically, it includes Omega-3 fatty acids, which are not found in mammalian products. Omega-3's are highly effective as antimicrobial agents and in modulating the inflammatory response of the acute wound healing stage (2)

Previous studies have shown that the fish skin grafts mediate significantly faster healing compared to porcine or amniotic/chorionic products (3,4). Additionally, previous studies also show relatively short average time until complete healing and analgesic effects (attributed to the Omega-3 fatty acids) (5). The objective of this case series is to display FSG's powerful angiogenic ability by providing evidence of its healing over avascular structures.

### Methods

Wounds were prepared as necessary and FSG was applied. Deeper wounds had graft applied in multiple layers. The incorporating graft islands and peripheral wound edges were fenestrated at follow up visits, for saturation of blood to allow for further incorporation of graft. Of note, applying the graft in layers and fenestrating the wound post-operatively contrasts directly with post-operative protocols of other grafts. Additional grafting was performed as needed.

### Case Study 1

62 y/o female w/ PMH of HTN, RA, controlled DM2 and social history of smoking cig. B. Severe pain and 2-3" x 4" leg pain. She has had a reconstructive and other procedures performed in the 30s after which her pathologies returned. She had a foot FSG autograft performed as well as lesser TPO and distal debridement with debridement procedures.

One week post-operatively, patient followed up with an infected necrotic residual wound which was deep to bone with exposed hardware. Patient was immediately taken for and had and extensive debrar application, and FSG was applied once the infection was cleared.



### Case Study 2

68 y/o paralytic male with PMH of DM2 and PAD presented with a pressure wound with Achilles tendon exposure. Grafting was performed and an external fixator was applied to offload the wound.



### Case Study 3

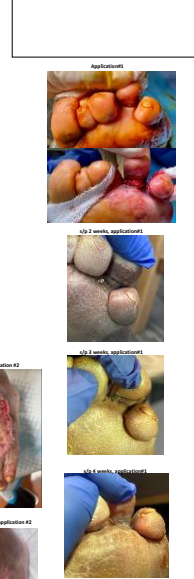
48 y/o male w/ PMH of DM2 and smoking history had a traumatic degloving injury which resulted in a deep wound to the footbed with exposed tendons. For this patient, Medical honey was applied over the FSG.

Of note, this patient was a Charity care case, therefore as minimal as possible intervention had to be performed due to the financial constraints.



### Case Study 4

62 y/o F w/ PMH of DM2 with neuropathy, HTN, CAD reports with a left 4th AF toe wound with tendon exposed for an unknown duration. Due to the age of the patient, her family was pushing for a toe amputation due to the possible inconveniences of the wound healing process.



### Results

As evidenced in the clinical photographs, in all cases after only a single application of the graft there is significant granulation tissue over both exposed tendon and bone, without the assistance of NPWT. Additionally, as the wounds healed into healthy skin one notes an initial purplish hue of the new forming skin, very similar in appearance to a healing Split Thickness Skin Graft. All wounds resulted in healthy, thick skin formed in accordance with the Langer lines.

### Conclusion

FSG's capacity to heal over avascular structures without the need for NPWT makes it a promising treatment for wounds with exposed tendons or bone. Observing how similar the graft healing process is that to a STSG, due to the graft's homologous structure to human skin, proves the FSG to be a viable alternative to a STSG. Further investigation of FSG's versatility is warranted to provide more evidence of its effectiveness and wide applicability.

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# Flexible Fixation for a Chronic Lisfranc Injury: A Case Report

Zoe Simaz DPM, PGY-3; Brian Penrose, DPM; Morgan Faanes, DPM

Statement of purpose: To discuss flexible fixation for Lisfranc Injury  
Saint Joseph Health System – Mishawaka, IN

## Introduction

Lisfranc fractures/dislocations can be caused by high energy trauma, such as motor vehicle accidents, or more commonly, low energy trauma, such as those seen in sports.<sup>1</sup> Conservative management can be considered in midfoot sprains without the ligamentous complex, which can best be seen on MRI.<sup>2</sup> However, studies show that if there is 2 mm or more of diastasis between the second metatarsal base and medial cuneiform on weightbearing radiographs relative to the contralateral side, the joint is unstable and surgery is recommended.<sup>4,5,6</sup>

The two mainstays of surgical treatment for Lisfranc injuries have been open reduction internal fixation with plate or screws and tarsometatarsal joint arthrodesis. However, within the past 10-15 years, flexible fixation with the use of a suture button/tightrope, has been studied as another alternative for Lisfranc injuries. Similar to flexible syndesmosis fixation in the ankle, this allows for more anatomic movement along the Lisfranc joint. Rigid fixation using screws and plates prevent motion in the joint which may lead to screw breakage. Using non-rigid fixation avoids the need for possible future surgeries to remove hardware.<sup>7</sup>

This case study reviews the use of tight rope fixation (Arthrex Mini Tightrope CMC fixation) on a 16-year-old female athlete with a chronic Lisfranc injury. Given the patient's young age, and desire to return to athletics quickly and avoid future surgeries, we believed she would greatly benefit from flexible fixation.

## Case

A 16-year-old female presented to clinic 9 months after twisting her right foot in basketball. Although she felt immediate pain, she continued to play sports, including basketball and swimming. She reported an achy pain to her right foot, worse with activity and relieved by rest. Patient was healthy, denying any medical problems, medications, or significant family history. Patient had multiple x-rays performed by her PCP, which were negative for any Lisfranc diastasis or bony abnormalities. Upon exam, neurovascular status was normal, no ecchymosis or edema was noted. Patient reported pain with side-to-side squeeze of the metatarsal heads and with deep palpation of the first interspace consistent with a Lisfranc injury. Due to the chronicity of the patient's symptoms, an MRI was ordered with findings consistent with complete rupture of the Lisfranc ligament as well as healing fracture of the second metatarsal base. It was discussed with the patient and her father that surgical intervention would be necessary given the delay in treatment and continued pain. We wished to avoid arthrodesis due to patient's young age and avoid ORIF given the possibility of hardware removal. Therefore, tightrope fixation was pursued utilizing the Arthrex Mini TightRope CMC Fixation device.

## Procedure

Following IV sedation, thigh tourniquet application, and scrubbing, prepping, and draping the foot, attention was directed to the right foot. A 3 cm linear incision was made with a #15 blade along the lateral aspect of the base of the second metatarsal and intermediate cuneiform. Reduction of the medial cuneiform second metatarsal joint was achieved with a bone clamp.

The Arthrex 1.1 mm tapered suture passing K wire was then advanced from the lateral aspect of the base of the second metatarsal to the medial aspect of the medial cuneiform and used to pull the mini tight rope construct through to the medial aspect of the medial cuneiform. The suture was tightened and the oblong button contacted the lateral side of the second metatarsal base. Fluoroscopy was utilized to verify the button was laying fully against the bone. A 2 cm horizontal incision was made along the suture passing K wire exiting the skin along the medial cuneiform. The second oblong button was loaded onto the suture and brought down to the medial aspect of the medial cuneiform. The medial button was tightened down to the bone with four knots. Optimal reduction of the joint was visualized on fluoroscopy.

Following closure of the incision site, patient was placed in a posterior splint and instructed to remain completely non-weightbearing to her right foot with crutches or a knee scooter.



Pre-operative MRI

Perioperative fluoroscopy

4 months post-operative

## Post-operative course

Sutures were removed at 2 weeks post op. As patient reported only 2/10 pain at -3 weeks, she was allowed to partially weight bear in CAM boot and start swimming. At 6 weeks following surgery, patient continued to report 2/10 pain, so she was instructed to remove the CAM boot for full unprotected weight bearing around the house, while continuing protected weight bearing for longer distances. She was referred to physical therapy at this time. 10 weeks following surgery, patient transitioned into normal shoes and began running and playing tennis.

4 months following the repair, patient reported 0/10 pain with most activities, with the exception of some occasional soreness along the medial aspect of her foot after participating in a hard workout. Patient had full range of motion and strength and denied pain to the Lisfranc ligament. It should be noted that the patient did not get the radiographs ordered at the 3- and 6-week mark. However, due to her vast clinical improvement, we felt comfortable allowing her to increase her activities as tolerated. Patient was released to full activity at this time. Patient's final radiographs show continued reduction of her Lisfranc joint.

## Discussion

Historically, Lisfranc injuries have been surgically repaired with either open reduction internal fixation or tarsometatarsal joint arthrodesis. There has been contradicting literature regarding whether primary arthrodesis or ORIF is better.<sup>8,9</sup> Proponents of open reduction internal fixation wish to avoid fixing a joint if unnecessary as TMT fusion results in loss of motion for the medial and middle column of the foot.<sup>4</sup> With a fusion, complete function is unable to be restored, which is especially important in patients with high activity levels.<sup>2</sup> However, proponents of TMT arthrodesis state that primary fusion avoids the possibility of follow up procedures for hardware removal, which is often seen in ORIF.<sup>8,9</sup> Many current studies advise that arthrodesis is reserved for chronic injuries (>6 weeks), isolated ligamentous injuries, severe comminution, and salvage procedures.<sup>2,5</sup>

Flexible fixation has become more popular within the past two decades, allowing for more anatomic movement along the Lisfranc joint and decreasing the need for possible further surgery to remove painful or broken hardware. Indeed, a cadaveric study showed that using a 3.5 transarticular screw can lead to significant damage of the tarsometatarsal joint.<sup>2</sup> In a retrospective study looking at Lisfranc suture button fixation in 84 patients, Cottom et al reported that VAS and AOFAS scores were found to increase significantly along the 3 year follow up.<sup>10</sup> In a literature review by

Andersen et al, when looking at four different studies using flexible fixation on 142 patients, subjective pain data was utilized to evaluate improvement and a significant majority of patients reported no pain at their final post operative appointment. In addition, the majority of patients maintained proper alignment and reduction of the midfoot at the Lisfranc joint. No revision cases were necessary for the flexible fixation.<sup>11</sup> Overall, proponents of flexible fixation also report earlier weight bearing and mobilization. Cottom et al reported a weightbearing at an average of 11 days following surgery.<sup>10</sup>

While the chronicity of our patient's injury may have indicated an arthrodesis, we discussed with the patient and her father that given her young age and desire to return to sports, we believed that it would be in her best interest to try flexible fixation. Indeed, the patient did so well at the 3 week post operative mark, that she was allowed to begin swimming and partial weightbearing in the CAM boot. The patient continued to admit to decreased pain and increased range of motion. Upon the patient's final follow up visit, she denied all pain except for occasional tenderness to the medial aspect of the foot after a long workout. This can most likely be attributed to the placement of the suture button on the medial aspect of the medial cuneiform, along the insertion of the anterior tibial tendon. It is important to ensure when placing the medial button, that it is sitting fully on the bone without any interposing soft tissue. We may have benefited from increasing the size of the medial incision site in order to get better exposure when placing the medial button.

While the literature on using flexible fixation for Lisfranc injuries has increased in recent years, still more is necessary, especially regarding a standardization of weightbearing protocol. Upon this literature review, Cottom et al had the earliest weight bearing at 11 days.<sup>10</sup> The remaining studies allowed weight bearing at 6 weeks or later. Allowing our patient to weight bear and start swimming at 21 days was a more novel approach and the patient did well with this.

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# Foot and ankle reconstruction using a standalone nanocrystalline hydroxyapatite bone graft to induce early, rapid bone healing

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## Purpose

To analyze the use of a nanocrystalline hydroxyapatite bone graft putty (NanoBone® Bone Graft, Artoss GmbH, Rostock, Germany) in foot and ankle surgery as a standalone bone graft.

## Methods

A prospective, consecutive patient study in upper and lower extremities showed nanocrystalline hydroxyapatite bone graft alone gave equivalent fracture healing rates and lower complication rates than autograft alone.<sup>1</sup> This multicenter prospective patient registry was designed to evaluate nanocrystalline hydroxyapatite as a standalone graft in foot and ankle surgery with radiographic measures (fusion success, instrumentation integrity) and clinical outcomes (symptom and functional improvement). Patients had been diagnosed with pathology of the foot or ankle, failed conservative treatment, and surgery with bone graft was medically necessary. Evaluations were completed at pre-op, post-op, three, and six months.

## Acknowledgements and Contact

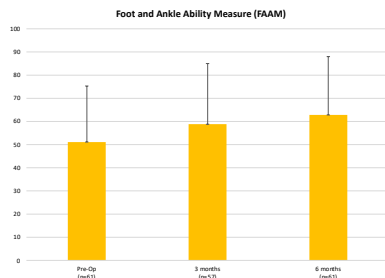
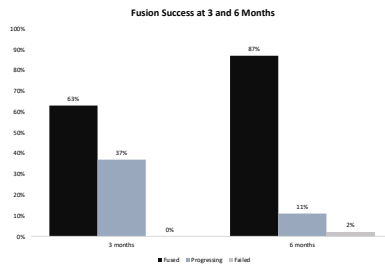
This post-market clinical registry was supported by Artoss, Inc.  
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6-month postoperative medial and lateral X-rays demonstrating well-fused triple arthrodesis using 20ml of nanocrystalline hydroxyapatite<sup>1</sup>

## Analysis

Eight investigators at seven sites enrolled a total of 217 patients. This poster presents 61 patients who have completed six month follow-up. There were 37 females and 24 males with an average age of 59±13 years. Their average height was 67.5 inches, average weight was 206±54 pounds. Indications included ankle fusion, triple arthrodesis, midfoot, MTP fusions, and others. In all cases, the graft was used with internal fixation, the majority using screws, plates, and staples. On average, patients received 7ml of graft but there was considerable variability from 1 to 20ml.



## Conclusions

In this extremely heterogeneous patient population, nanocrystalline hydroxyapatite bone graft used alone provided early consistent fusion.

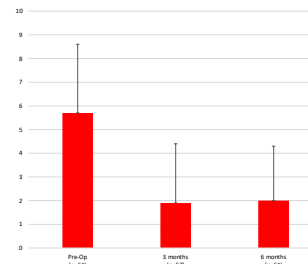
## Results

Fifty-three patients achieved fusion with another seven progressing toward fusion. One patient did not fuse due to instrumentation failure. Only two patients were non-weight bearing, included the failed fusion. FAAM Scores improved from 51.1 pre-op to 62.8 and level of function from 45.1 to 72.6. VAS pain scores improved from 5.7 to 2.0. Neurological status improved in 4 patients and remained the same in 57. Narcotic pain medication was discontinued by 33 patients and decreased by 10. It was increased in 2 patients and 16 had never used narcotics. Non-narcotic pain medication was discontinued in 26 patients, decreased in 15, and remained the same in 8. Thirteen patients did not use non-narcotic pain medication.

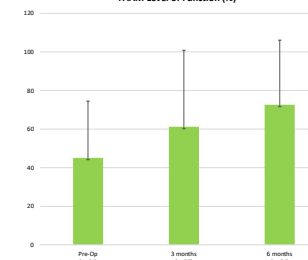
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## VAS Pain Scale



## FAAM Level of Function (%)



3-month postoperative lateral and AP X-rays demonstrating stable, intact implants with good initial fusion using 2.5ml of nanocrystalline hydroxyapatite<sup>2</sup>

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BACK

## Abstract

Giant cell tumors of tendon sheath (GCT-TS) also characterized as giant cell tumors of low malignant potential (GCT-TS LMP) are extremely rare entities found most frequently in the extremities. It appears as an enlarging painless mass and has a synovial origin. GCT-TS is approximately 1.6% of all soft tissue tumors. The GCT-TS of the tibialis anterior tendon is very rare, and recurrence has not been reported in the literature. The authors present a rare case of a 71-year-old male with a GCT-TS within the Anterior Tibialis tendon. The soft tissue mass is characterized by a mix of giant cell reaction & gouty tophus occurring within the Tibialis Anterior Tendon.

## Introduction

Tenosynovial giant cell tumor, also termed giant cell tumor of the tendon sheath (GCT-TS), is a benign, slow growing tumor that normally originates from the tendon sheath or bursa. It can be intraarticular or extraarticular. It's a type of tumor that is more commonly documented in the hands. The foot and ankle account for only 3-5% of all GCT-TS in the body.

Literature regarding treatment strategies for GCT-TS in the foot and ankle is limited due to a scarcity of patients with this tumor type. Other tumors that mimic GCT-TS radiographically include but are not limited to pigmented villous nodules, fibroma of the tendon sheath, synovial chondromatosis, foreign body granuloma, chronic tophaceous gout. Advanced imaging is recommended for appropriate diagnosis and treatment plans.

Histologically, GCT-TS resemble their counterpart, giant cell tumor of bone, in which they are characterized by multinucleated giant cells against a background of mononuclear spindle-shaped stromal cells.

Here we report a rare case of a soft tissue mass characterized by a mix of giant cell reaction & gouty tophus occurring within the Tibialis Anterior Tendon.

## Case Study

A 71-year-old male with a medical history of Hypertension, Hyperlipidemia, Idiopathic Chronic Gout (currently on long term allopurinol), Radiculopathy of the cervical region, Osteoarthritis, and Left Ankle Open Reduction Internal Fixation due to previous trauma, presented with a progressively enlarging, painless soft tissue mass to the anterosuperior aspect of the Left Ankle, proximal to the ankle joint. To note, the patient was admitted to previously having Left Ankle surgery secondary to trauma in 2010, with no hardware noted in the site of soft tissue mass. The mass had been present for over 1 year as per the patient. In the past year, the mass developed in size and remained painless with slight discomfort in sitae gear.

On examination, the mass was approximately 4.2 x 2.0 cm in size, firm in consistency, non-tender, and non-reducible (Figure 1). Radiographic evaluation (Figures 2.1 and 2.2) only revealed an increase in soft tissue volume and density on the anterior aspect of the ankle with no bony erosions or involvement appreciated. Due to the growing size of the mass, magnetic resonance imaging studies were performed which revealed that the tumor was located in front of the tibio-talar joint surface which is hypertense on T1 weighted imaging (Figure 3.1 and 3.2) and mild hypointensity on T2 weighted imaging (Figure 3.3) with severe fusiform thickening of the tibialis anterior tendon suggesting giant cell tumor of the tendon sheath and/or tenosynovitis of the tibialis anterior tendon sheath. There was no significant osseous erosion in the adjoining bone.

Limited evaluation due to previous ORIF artifact (Figure 3.1). All risks, benefits, and complications of surgical intervention were verbalized to the patient, and the patient elected to proceed with excision of the soft tissue mass.

## Conclusion

We have presented a rare case of a 71-year-old male with a GCT-TS within the Anterior Tibialis tendon. The soft tissue mass is characterized by a mix of giant cell reaction & gouty tophus occurring within the Tibialis Anterior Tendon. We believe that this case warrants further research.

## Figures

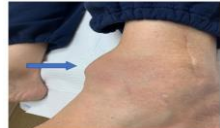


Figure 1. Preoperative photograph of left ankle, demonstrating mass (arrow) on the anterosuperior aspect.



Figure 2.1. Lateral view radiograph showing increase in soft tissue volume & density anterior to the tibiocalcaneal joint in the area of soft tissue mass.



Figure 2.2. Ankle mortis view radiograph showing increase in soft tissue density without bone involvement.

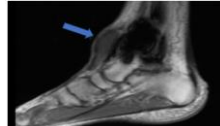


Figure 3.1. MRI of Left Lower Extremity Sagittal T1 hypointense signal (arrow) within the tumor with ankle arthral secondary to previous ORIF seen.

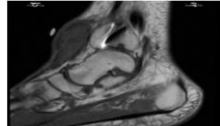


Figure 3.2. MRI of the Left Lower Extremity Sagittal T1 hypointense signal within the tumor.

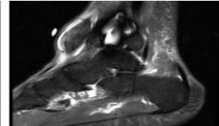


Figure 3.3. MRI Sagittal T2 view tumor measures up to 2.2 x 2.1 x 4.1 cm (AP x ML x CC), with large amount of fluid in the tibialis anterior tendon sheath.



Figure 4. Intraoperative photograph of gelatinous like substance (arrow) seen upon dissection of Tibialis Anterior tendon sheath.



Figure 5. Intraoperative photograph soft tissue mass within the Tibialis Anterior tendon.

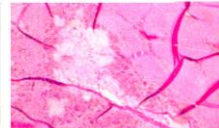


Figure 6. Needle-shaped crystals surrounded by histiocytic reactions is visualized.

## Operative Technique

The patient was placed in the supine position and underwent IV sedation with a regional ankle block performed. The left lower extremity was prepped and draped in a normal sterile fashion. A high ankle tourniquet was applied, however, was not inflated. A 4-cm incision was made over the pole of the Tibialis Anterior tendon with careful layered dissection both medially and laterally down to the tendon sheath. Upon further dissection, the tendon sheath encompassing the Tibialis Anterior tendon was found to be very hypertrophic and thickened with its appearance being red in color. After careful dissection and preservation of the tendon sheath, a gelatinous-like substance was encountered (Figure 4) which was removed and sent to the laboratory for pathological identification. The soft tissue mass was then noted to be within the Tibialis Anterior tendon (Figure 5) and removed with extensive debridement and debulking of the tendon.

No definitive signs of infection such as pus drainage or malodor were noted. After removal of the mass, along with debrulking and tabularization of the Tibialis Anterior tendon, the operative site was closed primarily. Postoperatively, the patient was placed in a short-leg fiberglass cast with the maintenance of the foot and ankle at 90 degrees with strict non-weight-bearing to the Left Lower extremity.

The resected tumor measuring 4.2cm x 2.0cm x 1.3cm and tendon sheath measuring 2.6cm x 2.0cm x 1.2cm were sent to Dannon Department of Pathology for histological evaluation. The dermis contains crystals of needle-shaped crystals which are surrounded by a considerable histiocytic reaction (Figure 6). The tumor and tendon sheath resulted in fibrovascular connective tissue and synovial tissue with gouty tophus and giant cell reaction.

## Discussion

GCTTS is a benign, slow-growing tumor that originates from the tendon sheath or bursa. GCTTS is a tumor that is often found in the hand. Previously, it has been reported that only 3-5% of GCTTS is found in the foot and ankle. Symptoms of GCTTS include pain, joint swelling and limitation of movement. GCTTS can be aggressive as they can erode adjacent bones by pressure. Strong diagnosis of GCTTS is advised for better outcomes. Radiographs can show abnormal features such as cortical erosion of bone or intrasynovial involvement. Ultrasoundography can be used to provide information on tumor vascularity, tumor size, and relationship to the surrounding tissue. It will appear as a solid homogeneous hypochoic mass. In addition, MRI can help with diagnosis. GCTTS can be identified as both low-signal intensity on T1 and T2 weighted images. Excision of the mass has seen a high recurrence rate, especially when there is bone involvement. Optimal treatment of GCTTS involving adjacent structures including cartilage and bone is controversial. In the foot and ankle, one study reported a local recurrence to be 20% after excision. Pan et al suggested in their review of patients with GCTTS in the lower extremity that articular structures should be exposed. They advised that these structures require excision and that adjuvant radiotherapy treatment to prevent recurrence. One study involving localized GCTTS in the thumb, conducted radiotherapy treatment with a favorable outcome.

Gout arises from the deposition of uric acid crystals in joints most typically occurring in the big toe joint causing redness, swelling, and severe pain. Unlike most other rheumatological diseases, gout is unique in that it can be managed and often cured with the right treatment. Gout is caused by either overproduction of uric acid which is seen in 10% of patients, or a renal underexcretion, which is seen in the 90% majority. Uric Acid is the end product of purine metabolism and normal levels within the human body is 6.8mg/dL. Levels exceeding this have a higher prominence of gout flares up in patients. The crystals tend to precipitate faster at lower temperatures, which is why the extremities like the toes tend to have more frequent flares. Gout can either be asymptomatic, acute, intercritical, or chronic. Acute gout is rapidly developing inflammation, and a period between acute flares up is known as the intercritical period. Chronic gout is characterized by long term inflammation from several acute attacks, leading to gouty tophi present in the joint.

Tophaceous gout characterizes the chronic phase of disease and in rare instances present in tendons of hands and knees. Only one other case has been reported about gouty tophi in the quadriceps tendon in a patient who had a history of gout. No previous record of presentation below the leg and specifically in the tibialis anterior tendon has been reported. Gout can mimic GCT in tendons by forming tumor-like masses and be misdiagnosed as an infection or a neoplasm. Given the deceptive nature of presentation of GCT vs gout, the history, radiographic imaging and clinical presentation have to be considered to determine the treatment of choice.

This case demonstrates that a gouty tophus may mimic a soft-tissue neoplasm although not obvious from initial radiographs. Given that there were no calcifications or bone involvement, there was a low suspicion of gout initially. Because of known clinical history and recurrence rate of gout, aspiration was not the first line of treatment in this case. The initial clinical and radiological diagnoses were that of a giant cell tumor of tendon sheath. GCTTS has a low malignant potential, however the etiology remains unclear.



## A Retrospective Cohort Analysis

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### Statement of Purpose

Gunshot wounds (GSWs) to the foot/ankle present significant challenges given their functional biomechanics. Scant, wide-ranging data on the prevalence of GSW's to the foot/ankle exist even though the extremities represent the largest fraction of GSW's<sup>1</sup> with a large number to the foot alone.

### Literature Review

In a study that looked at United States emergency departments between 1993-2010 found that of 69,111 patients who were admitted after a non-fatal gunshot injury, 667 (1.0%) were due to self-inflicted gunshots to the foot alone. This data did not include gunshot wounds to the foot that were not self-inflicted.<sup>2</sup> There are several studies in the literature outlining the outcomes of gunshot wounds to the foot and ankle, however to the authors knowledge, there are no studies that analyze morbidity of gunshot wounds to the foot with regards to the three recognized anatomic regions: forefoot, midfoot, and hindfoot. One study assessed functional outcomes based on two regions titled Zone 1 and Zone 2, based on whether the injury was distal or proximal to the midtarsal joint, respectively.<sup>3</sup> This study aims to assess the morbidity and epidemiology of gunshot injuries to the forefoot at a level 1 trauma hospital. The authors hypothesize that forefoot injuries are less morbid than injuries involving the midfoot or hindfoot.

### Methods

We reviewed emergency department visits at Detroit Receiving Hospital from the years 2000-2019, and used an isolated gunshot injury to the forefoot as the inclusion criteria. The forefoot was defined as the anatomical region distal to the tarsometatarsal joints. Data that was derived included sample size of patients meeting the inclusion criteria, gender, ethnicity (African America, White, or Other), age, and length of stay (including with or without surgical intervention). Length of stay was categorized into four ranges: 0-1 days, 2-3 days, 4-7 days, and 8 or more days.

	Gender
Male	44 (93.62%)
Female	3 (6.38%)

	Age
Range	15-64
Median	26
Mean	28.68

	Ethnicity
African American	39 (82.98%)
White	7 (14.89%)
Other	1 (2.13%)

Days	Length of Stay	Requiring Intervention
0-1	24 (51.1%)	5 (10.64%)
2-3	14	14 (29.79%)
4-7	7	7 (14.89%)
8+	2	2 (4.26%)

	Length of Stay
Median	1 days
Mean	2.43 days

### Results

47 individuals met the inclusion criteria, including 44 males (93.62%) and 3 females (6.38%). Of the 47 individuals, 39 represented American American (82.98%), 7 represented White (14.89%), and 1 represented Other (2.13%). Ages ranged from 15-64 with an average age of 28.68 and median age of 26. Of the 47 individuals, 24 spent 0-1 days at the hospital (51.1%), this included discharge from the emergency department or a short inpatient stay. Of the 24 patients with a 0-1 day stay, 5 required surgical intervention (20.83%), and 19 did not (79.17%). 14 patients stayed between 2-3 days (29.79%), all requiring intervention. 7 individuals were admitted between 4-7 days (14.89%) and all required intervention. Lastly, 2 patients stayed over 8 days (4.26%) and required intervention. The average length of stay was 2.43 days and the median length of stay was 1 day.

### Analysis and Discussion

While gunshot wounds to the foot and ankle have the potential to be debilitating injuries with long-term sequelae, this study shows that injuries to the forefoot have a significant chance of not requiring operation (40.43%) and may even require a length of stay between only 0-1 days (51.1%). In our study, young (mean age 28.68) males (93.62%) represented the largest demographic of individuals affected by gunshot wounds to the forefoot. Further studies are warranted to assess the morbidity of injuries in the midfoot and hindfoot, as well as functional outcomes in each of the three anatomical groups.

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Disclosures: None



# Impact of Podiatric Surgery Consultation for Foot and Ankle Wounds on Patient Outcomes in a Community Hospital

Stephanie Behme, DPM, Zeeshan S. Husain, DPM FACFAS, Olga J. Santiago, PhD MHA



## Background

- Foot and ankle wounds are a common cause of hospital admission.
- Podiatric surgery consultation is a key component of the multidisciplinary approach to foot and ankle care.
- Podiatric surgery consultation is associated with improved patient outcomes, including reduced length of stay and lower costs.
- Podiatric surgery consultation is associated with improved patient satisfaction.
- Podiatric surgery consultation is associated with improved patient safety.

## Hypothesis

- Podiatric surgery consultation is associated with improved patient outcomes, including reduced length of stay and lower costs.
- Podiatric surgery consultation is associated with improved patient satisfaction.
- Podiatric surgery consultation is associated with improved patient safety.

## Methods and Materials

- Retrospective cohort study of patients with foot and ankle wounds.
- Patients were divided into two groups: those who received podiatric surgery consultation and those who did not.
- Primary outcomes included length of stay, 30-day readmissions, and patient satisfaction.
- Secondary outcomes included patient safety and patient satisfaction.
- Data was collected from the hospital's electronic medical records.
- Statistical analysis was performed using logistic regression.
- Results showed that patients who received podiatric surgery consultation had significantly shorter lengths of stay and lower rates of 30-day readmissions.
- Podiatric surgery consultation was also associated with improved patient satisfaction.
- Podiatric surgery consultation was associated with improved patient safety.

Significant factors	No Podiatric Consultation (n = 164)	Podiatric Consultation (n = 142)	p-value
Length of stay (days)	10.5 (SD 4.2)	7.8 (SD 3.1)	<0.001
Previous amputation	15 (9.2%)	12 (8.5%)	0.85
Main complaint			
Diabetes	100 (61.0%)	85 (60.0%)	0.92
Surgery during admission	100 (61.0%)	85 (60.0%)	0.92
Types of surgery			
Amputation	10 (6.1%)	8 (5.6%)	0.85
Debridement	90 (54.9%)	77 (54.4%)	0.92
Flap	10 (6.1%)	8 (5.6%)	0.85
Other	10 (6.1%)	8 (5.6%)	0.85

Table 1. Comparison of patient characteristics between those who received podiatric surgery consultation and those who did not.



Significant factors	30-day Readmissions		p-value
	No (n = 262)	Yes (n = 24)	
Podiatric consultation	150 (57.3%)	12 (50.0%)	0.001
Length of stay (days)	10.5 (SD 4.2)	7.8 (SD 3.1)	<0.001
Previous amputation	15 (9.2%)	12 (8.5%)	0.85
Main complaint			
Diabetes	100 (61.0%)	85 (60.0%)	0.92
Surgery during admission	100 (61.0%)	85 (60.0%)	0.92
Types of surgery			
Amputation	10 (6.1%)	8 (5.6%)	0.85
Debridement	90 (54.9%)	77 (54.4%)	0.92
Flap	10 (6.1%)	8 (5.6%)	0.85
Other	10 (6.1%)	8 (5.6%)	0.85

Table 2. Comparison of patient outcomes between those who received podiatric surgery consultation and those who did not.

## Results

- Description of the study sample
- Podiatric surgery consultation was associated with significantly shorter lengths of stay and lower rates of 30-day readmissions.
- Podiatric surgery consultation was also associated with improved patient satisfaction.
- Podiatric surgery consultation was associated with improved patient safety.
- Adjusted logistic regression
- Podiatric surgery consultation was associated with significantly shorter lengths of stay and lower rates of 30-day readmissions.
- Podiatric surgery consultation was also associated with improved patient satisfaction.
- Podiatric surgery consultation was associated with improved patient safety.



No financial disclosures

Abbreviations: ASPS, American Society of Podiatric Surgeons; DPM, Doctor of Podiatric Medicine; FACFAS, Fellow of the American College of Foot and Ankle Surgeons; MHA, Master of Health Administration.

## Conclusions

- Podiatric surgery consultation is associated with improved patient outcomes, including reduced length of stay and lower costs.
- Podiatric surgery consultation is associated with improved patient satisfaction.
- Podiatric surgery consultation is associated with improved patient safety.
- Podiatric surgery consultation is a key component of the multidisciplinary approach to foot and ankle care.
- Podiatric surgery consultation is associated with improved patient safety.
- Podiatric surgery consultation is associated with improved patient satisfaction.
- Podiatric surgery consultation is associated with improved patient safety.

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BACK



# Influence Of Adequate Debridement & Placental-Derived Allografts On Diabetic Foot Ulcers

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ASPS 2022

## INTRODUCTION

Debridement plays an essential role in the TIMERS framework for hard-to-heal wounds.<sup>1</sup> Debridement when performed with frequency and adequacy has been shown to rebalance the healing cascade converting the unfavorable molecular environment of a chronic wound into a pseudoacute wound.<sup>2</sup> TIMERS also recognizes the need to “step up” to Advanced Treatments when the trajectory towards wound closure stalls.<sup>3</sup> In addition to a retrospective analysis of Medicare data related to chronic lower extremity diabetic ulcers (LEDUS), this study also evaluated two advanced treatments, dehydrated human amnion/chorion membrane and dehydrated human umbilical cord (MIMEDX Group Inc., US) as adjunctive therapies to surgical debridement for closure in hard-to-heal diabetic foot ulcers (DFUs).

## METHODS

Debridement adequacy in the prospective RCTs was adjudicated by three blinded wound care specialists (Figure 1). Treatments included two placental-derived allografts (PDAs), dehydrated human amnion/chorion membrane (DHACM, n=54) or dehydrated human umbilical cord (DHUC, n=101), compared with standard of care (SOC, n=110). The key outcome was the influence of adequate debridement on rates of complete closure within 12 weeks. Additionally, a retrospective analysis of 2015–2019 Medicare claims for DFUs that received routine debridement at intervals ranging from every 1–7 days (18,900 total episodes), 8–14 days (35,728 total episodes), and every 15 days or greater (34,330 total episodes) was performed.

## RESULTS

Within the RCTs, adequate debridement occurred in 202/265 (76%) of patients, 90/110 (82%) SOC ulcers, 45/54 (83%) of DHACM-treated ulcers, and in 67/101 (66%) of DHUC-treated ulcers. Complete closure occurred in 150/202 (74%) of adequately debrided ulcers, and in only 13/63 (21%) of ulcers without adequate debridement,  $p<0.0001$ . Debridement was the most significant factor for closure even when controlling for other clinical characteristics (Table 1).

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Figure 1. Examples of inadequate debridement: significant callous and epibole present (a) and adequate debridement: evidence of pairing of callous and removal of epibole, moist wound bed, no debris (b).



## RESULTS

Within the Medicare claims data 21% (18,900/88,958) of episodes treated with SOC only had debridement intervals of  $\leq 7$  days (Figure 2). Short debridement intervals in combination with the use of DHACM demonstrated statistically significant better outcomes than SOC including (Figure 3): 65% fewer major amputations ( $p<0.0001$ ), higher DFU resolution rates ( $p=0.0125$ ), 42% fewer emergency room visits ( $p<0.0001$ ) and reduced usage of other hospital resources (admissions and readmissions).

Table 1: Cox Regression Model Results

Variables	Parameter estimate	SE	Chi-squared	p-value	HR	95% CI for HR	
						Lower	Upper
Debridement: adequate versus inadequate	1.793	0.297	36.345	<.0001	<b>6.006</b>	3.353	10.756
Treatment: PDA versus SOC	0.715	0.172	17.283	<.0001	<b>2.045</b>	1.459	2.865
BMI, <30kg/m <sup>2</sup>	0.398	0.166	5.722	0.017	1.489	1.075	2.064
Baseline wound size, <2.8cm <sup>2</sup>	0.731	0.197	13.705	0.000	2.076	1.410	3.057
DFU position: non-plantar	0.528	0.176	8.999	0.003	1.695	1.201	2.393
History of amputations, no versus yes	0.419	0.218	3.684	0.054	1.521	0.991	2.333
DFU location: toe versus hindfoot	0.775	0.329	5.548	0.019	2.170	1.139	4.134
DFU location: forefoot versus hindfoot	0.674	0.279	5.830	0.016	1.963	1.135	3.393
DFU location: midfoot versus hindfoot	0.444	0.317	1.969	0.161	1.559	0.838	2.900

SE—standard error; HR—hazard ratio; CI—confidence interval; PDA—placental-derived allograft; SOC—standard of care; BMI—body mass index; DFU—diabetic foot ulcer

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Figure 2: Percent of 82,067 Medicare episodes receiving standard of care at the listed debridement intervals (bold). Included are the average number of debridements, and percent of diabetic foot ulcer resolution at one year for each interval

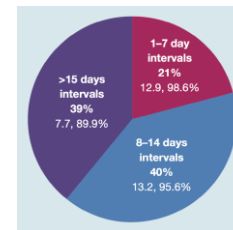
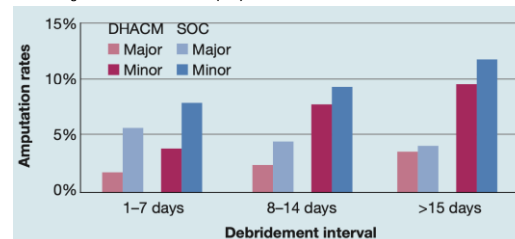


Figure 3: Comprehensively, Medicare amputation rates increased correlatively with longer debridement intervals. Major amputation rates were lowest when treated with dehydrated human amnion/chorion membrane (DHACM) and at debridement intervals of 1–7 days. Minor amputation rates were greatest for standard of care (SOC).



## CONCLUSION

Prospectively collected data examining the quality of debridement and retrospectively analyzed data examining the frequency of debridement supports routine adequate wound debridement, particularly at intervals of seven days, as an essential component of wound care. In addition, optimal use of placental-derived allografts improved outcomes and lowered the use of healthcare resources.

Scan Me



Poster development supported by MIMEDX Group, Inc.

BACK

The use of indocyanine green angiography has been utilized in general surgery, vascular surgery, plastic surgery, and wound care to help improve decision making and aid surgeons in the intra-operative setting. Specifically, indocyanine green angiography (ICGA) has been shown to aid in the assessment of tissue perfusion and vascular trauma guiding therapy and aiding in decision making for efforts in limb salvage and amputation.<sup>8</sup> Settembre, et al, in 2017 further showed after posterior tibial artery bypass, ICGA provides reliable information regarding increased perfusion after revascularization which can help predict possible failure of revascularization.

Frostbite has been notorious for lengthy hospitalizations and delayed resolution of pain and symptoms. Standard of care in acute frostbite treatment involves rewarming, delayed surgical treatment, medical management consisting of aspirin, buflomedil, prostacyclin, tissue plasminogen activator and iloprost which help increase vascular perfusion and hospitalization as the initial insult finalizes and demarcation precipitates.<sup>2</sup> Some reports state that clinical improvement can increase up to 30% during the recovery phase with traditional care<sup>3</sup>. Laser guided fluorescence ICGA imaging allows the surgeon to visualize the tissue perfusion in a real time scenario without waiting for clinical demarcation and can be used as a non-invasive adjunctive perfusion assessment which can be performed on anyone unlike ankle brachial index or toe brachial index. MacLennan et al, in 2021 reported on a case involving grade 2 frostbite to the left distal hallux. ICGA was used to follow the progression of reperfusion and not needed after

We present a case utilizing the intraoperative ICGA for surgical planning of bilateral forefoot stage 4 frostbite.

A forty-six-year-old male with past medical history of polysubstance abuse, post-traumatic stress disorder, and homelessness presented to the emergency department with altered mental status and stage 4 frostbite to bilateral forefeet. After several days of monitoring patient and with restored mentation, a lengthy discussion was held with the patient regarding treatment options which included standard of care, delayed surgical intervention pending demarcation, and acute amputation with use of intraoperative indocyanine green fluorescence imaging. Due to the patient's current socioeconomic situation and uncontrolled pain, he elected to proceed with acute amputation. Intraoperative fluorescence imaging demonstrated left foot perfusion cessation to the level of metatarsophalangeal joints one through five; and right foot perfusion cessation at the proximal interphalangeal joint of lesser digits and at level of first metatarsophalangeal joint. At this time, it was decided to amputate at these levels respectively. At the 4 week follow up it was noted that the right foot had necrosis and dehiscence while the left foot was healing as expected. When reviewing the ICGA it was found that level of chosen amputation was distal to the perfusion level on the ICGA. The patient was returned to the operating room for a more proximal amputation revision that corresponded to the ICGA perfusion. At subsequent follow-ups the patient went on to fully heal the amputation sites of the right foot.



Figure 1, ICGA demonstrating level of perfusion of the left foot MTPJs. Figure 2, ICGA demonstrating level of perfusion of the right foot to the 1st MTPJ and lesser digits PIPJ. Figure 3, Left foot clinical image of frostbite insult.



Figure 4, Status post left TMA, healed without complication at 3 weeks. Figure 5 and 6, Demonstrate right foot dehiscence from improper distal amputation level compared to ICGA.

This case demonstrates positive outcomes utilizing ICGA in acute frostbite. The transmetatarsal amputation (TMA) of the left foot, figure 4, was fully healed at 3 weeks and was noted to follow the perfusion level as noted in intraoperative imaging as noted in figure 1. Unfortunately, the right foot went on to wound dehiscence seen in figure 5 and 6. After critical review of the ICGA imaging it was noted that the amputation of the right foot was performed distal to the perfusion level, seen in figure 2.

The patient was subsequently taken back to surgery with an adequate amputation level based off the ICGA and healed without incidence or complication. Although, the patient went on to stump necrosis and dehiscence secondary to improper amputation level, we believe this further validates utilizing ICGA as a tool. ICGA was able to predict that the patient would not heal beyond the perfusion level, which ultimately, he did not until the proper amputation level was reached with the right foot and left foot.

As stated earlier, Sakkab et al demonstrated the use of ICGA for foot amputations with no better results than the control group. However, their study was limited only to amputations secondary to diabetic foot infection. Our study demonstrates the use of ICGA for a pure vascular insult with good outcomes. This is the first report that the authors are aware of utilizing ICGA for frostbite and direct vascular insult in the foot that went on to amputation. Masters et al, in 2018 report a single case study using ICGA and 20 hyperbaric oxygen (HBO) therapy sessions for frostbite in the hand. They reported they prevented a more proximal amputation of the left hand. HBO requires a significant time commitment and high compliance that our patient was not willing to undergo.

In conclusion we believe that ICGA can be used to determine the level of severe frostbite, which traditionally could take days/weeks for final demarcation and. ICGA can decrease hospital burden, infection risk and increased timing of finite patient treatment.

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## Keystone Flaps: a viable option to address skin and soft tissue malignancies in the lower extremities

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### PURPOSE

The goal of the case report is to demonstrate the use of flaps as an effective technique to reconstruct skin defects after surgical excision of skin malignancies.

### CASE STUDY

This case presents a 74-year-old male with a melanocytic lesion in the left leg that sought the opinion of a dermatologist. The physician performed a biopsy that tested positive for squamous cell carcinoma. Immediate radical resection of the lesion with wide borders was recommended, but the dermatologist informed the patient that she did not perform that type of surgery and referred the patient to our office. After the initial consultation, the surgery was planned for prompt removal of the lesion. The surgery was performed in the office setting under aseptic conditions (please see Surgical Methods). During the post-operative period, the patient followed-up with dressing changes weekly. Sutures were removed at 3 weeks. Patient continued to follow-up and was discharged from care at 8 weeks with no post-surgical complications. Patient continued to follow-up for a year, at which point the flap had completely assimilated with minimal scarring.



Figure 1. Initial Clinical presentation



Figure 2. Peri-lesional incision

### SURGICAL PROCEDURE

Patient consented to in office excision of left leg soft tissue lesion. Area was blocked with 10cc of 1% Lidocaine, which was injected around the lesion. The left leg was prepared and draped in normal sterile fashion. The procedure was performed using an elliptical incision with 1cm borders. The resected lesion with clean borders was sent to pathology for evaluation. The surgical area was reconstructed with a proximal pedicle Keystone flap and anchored in place with sutures and a bolster dressing. Patient was instructed to keep the surgical area clean and dry with intact dressings. Dressings were performed weekly in the office until sutures were removed.



Figure 3. Lesion was excised with an elliptical incision



Figure 4. Keystone Flap



Figure 5. Intra-Op Primary Closure



Figure 6. 6-week post-op follow-up

### DISCUSSION

The surgical procedure included a radical excision of left leg malignant lesion followed by proximal pedicle Keystone flap to reconstruct the skin defect. The specimen was sent for Pathology and the report concluded that the soft tissue lesion contained melanocytic squamous cell carcinoma. The pathology results also indicated that the markings were clean, and the lesion was removed completely. The patient's compliance with follow-up visits allowed for close observation of surgical site, viability and survivorship of the Keystone flap. The patient recovered well without complications and no malignancy recurrence to date.

This case study demonstrates flaps are a viable reconstructive solution to skin and soft tissue malignancy resection surgery. Another important point that this case study confirms is that biopsy of suspicious skin lesion is useful in diagnosis and timely treatment. Once a malignancy has been confirmed by biopsy, prompt and radical resection is the gold standard for treatment. This can lead to large deficit of skin for primary closure that can be easily repaired using a Keystone Flap. Primary closure of a skin defect can help avoid post-operative complications typically seen with open wounds such as infections.

### LITERATURE REVIEW

In the United States, an estimated 2 million cases of squamous cell carcinoma are diagnosed yearly. It is a malignant tumor affecting keratinocytes found in the epidermis with invasion into the dermis; and is the second most common form of non-melanotic skin cancer. Most cases are the result of chronic ultraviolet exposure, especially to sun-exposed areas such as the face, neck, arms, legs, and hands. Squamous cell carcinoma particularly affects fair skinned and immunocompromised individuals, and incidence often varies by level of outdoor activity. Older males are predominantly at risk for developing cutaneous squamous cell carcinoma, but studies show an increase in frequency to the lower extremities in the female population. The authors present a case of surgical excision of an uncommon melanocytic squamous cell carcinoma in the lower extremity. The goal of the case report is to demonstrate the use of flaps as an effective adjunct reconstructive technique to the gold standard of surgical excision for treatment of skin malignancies.

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BACK

## Introduction

Calcaneal osteomyelitis is difficult to manage, especially when associated with a large heel wound. Heel ulcers >4cm<sup>2</sup> are a major independent predictor of a BKA.<sup>1</sup> The coverage of a heel soft tissue is a challenge due to the structural and functional specifications of the heel and sole skin. It is difficult to surgically bring skin that is of similar structure and resistance with good vascular supply.

Partial calcaneotomies have been utilized to deepen the wound by removal of the calcaneal tubor and thus allowing for increased mobility of the surrounding wound edges to facilitate primary closures. However, despite this, there is often tension on the incision, resulting in a high rate of dehiscence, wound complications, and the need for revisional surgery.

There is no effective, widely accepted surgical treatment option. Reconstruction has been previously achieved by various methods including skin grafts, regional flaps, and free tissue transfers along with adjunct therapies like NPWT and HBOT. In our study we propose the use of a rotational flap from the posterior. This is a modified version of the original medial arch flap, supplied by the medial plantar artery that was first described by Harrison and Morgan in 1981.<sup>2</sup> Studies have shown the use of the rotational medial arch plantar flap to have a high rate of success given the similarities in skin structure, pressure resistance, and minimal donor morbidity.<sup>3</sup>

In our instance we modified the incision to create an arc that allowed for complete primary closure once the rotation was completed to cover the heel. This fasciocutaneous perforator flap is largely based on the superficial branch of the medial plantar artery.<sup>4</sup> By utilizing this arc of rotation concept, provides a big advantage of not having to tie the graft the donor site.

## Case Study

A 59-year-old patient with a history of DM with neuropathy, HTN, diverticulosis, and morbid obesity with a chronic right calcaneal ulceration down to fascia and bone, and underlying osteomyelitis treated for over 3 years with no improvement.

Patient originally presented over 4 years ago with a ulceration to the right plantar heel having sustained a full-thickness achilles tendon rupture. Unable to stay out of work, patient was non-compliant with immobilization and developed a progressively worsening calcaneal type gall.

Over the next two years patient underwent aggressive local wound care, negative pressure wound therapy (NPWT), total contact casting, surgical debridements along with primary repair of the achilles tendon, multiple courses of prolonged oral and IV antibiotics and hyperbaric oxygen therapy with no improvement.

The wound got deeper with the MRI revealing osteomyelitis of the posterior calcaneus. We discussed with patient and proposed the idea of performing a staged procedure that involved partial resection of the infected calcaneal bone, followed by subsequent coverage of the area with a rotational flap. We also saw the necessity for an external fixation device that would be needed for maintaining her foot in a optimal position during the flap healing process.

Though patient was diabetic with extensive neuropathy, the vascular assessment was relatively normal throughout the course of her presentation and not suggestive of any significant arterial occlusive disease. The wound healed in 4 weeks and the external fixator was promptly removed thereafter. Currently, 6 months later, patient continues to ambulate in a custom brace and shoe with no major issues.

Figure 1. Chronic heel wound prior to admission to the hospital



Figure 2. Pre-operative radiograph demonstrating changes at the posterior-inferior calcaneus

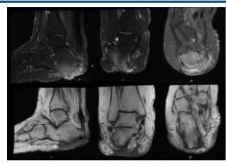


Figure 3. MRI of the right lower extremity demonstrating contiguous osteomyelitis in the posterior-inferior calcaneus



Figure 8. Full-healing noticed 1-month from planned procedure

## Course Of Treatment

- 2017
  - Developed right plantar heel wound, secondary to achilles tendon rupture
- 2018
  - Multiple wound debridements with primary closure, synthetic grafts and skin substitutes
- 2019
  - Achilles tendon repair
- Early 2021
  - Continued non-healing
    - MRI: acute osteomyelitis of posterior calcaneus.
    - Bone Biopsy: VRE bacteria
    - Procedure: Saucerization of calcaneus with primary closure, oral antibiotics and HBOT
- Late 2021
  - Continued non-healing
    - Wound culture: MDRO Pseudomonas
    - Long-term IV antibiotics
- 2/17/22
  - Admitted for fever and chills
    - Wound Exam: probe to fascia and bone
    - Vascular consult and tests ordered
    - Wound measurements: 4.0cm x 3.8cm x 1.0cm
    - Plan discussed for staged procedure.
- 2/20/22
  - Normal non-invasive vascular testing results.
    - MRI: osteomyelitis to posterior inferior calcaneus
- 2/22/22
  - 1st part of staged procedure
    - Partial Calcaneotomy with NPWT application.
    - Post debridement measurement: 5.5cm x 4.0cm x 1.5cm
- 2/24/22
  - 2nd part of staged procedure
    - Medial plantar fascio-cutaneous flap with primary closure and application of external fixator
- 3/24/22
  - Wound healed and external fixator removed. Below-Knee cast applied
- 3/28/22
  - Fitted for offloading brace and custom molded shoe
- 4/15/22
  - Started PT with custom brace and shoe

## Surgical Technique

- Flap was raised going medial to lateral with the blood supply originating from the medial plantar artery
- Incision site made down to the level of fascia
- Rotation was done from medial to lateral with full closure done with apex of deformity at 7 o'clock region
- Prior to closure, a 6x6cm Integra Primatrix graft was applied deep to the wound bed and secure appropriately utilizing 5-0 Monocryl to tack the corners
- 4-0 Nylon suture were placed using simple and Donati type suture techniques
- Once primary closure was completed, a Wright Medical Salvation 2 circular external fixator framing system was applied with the foot placed in 10 degrees of plantarflexion



Figure 4. Intraoperative image taken after debridement of ulceration with partial calcaneotomy



Figure 5. Rotational flap planning



Figure 6. Intraoperative image after completion of rotational flap

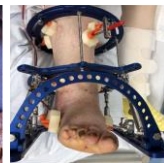


Figure 7. External fixation was applied in conjunction with the rotational flap

## Post-Op Protocol

- Nursing orders placed for the first 72 hrs post-op:
  - IV checks to flap site every hour
  - 4 pillow under RLE at all times
  - No dependent position allowed
  - Change JP drain every shift
- Dressings changes performed every day for first two weeks:
  - Pin site cleaned with saline and secure with betadine gauze
  - Miracelise applied around flap site to increase perfusion
  - Surgical site was dressed with Mepilex dressing
- Weight bearing status:
  - Day 1-3: Strict non-weight bearing with no declined position allowed
  - Day 4-7: Strict non-weight bearing with Smith's of declined position
  - Day 8 onwards: Strict non-weight bearing but allowed to stand and transfer to sitting chair. 10-15min of declined position 2-3 times a day
  - Ambulation for DVT prophylaxis: 10-15 minutes
  - IV antibiotics for 6 weeks (Vancomycin and Zosyn) gives the results of the intra-op bone culture that grew Pseudomonas, Providencia and Staphylococcus Culture

## Discussion

Calcaneal osteomyelitis is very challenging for patients and treating clinicians. Despite limb salvage efforts by clinicians, it has been reported that 52% of major amputations are performed in patients with calcaneal osteomyelitis.<sup>5</sup> The increased energy requirements and inability to ambulate without the use of prostheses or an assisted device, makes a proximal amputation undesirable to many patients. Based on evidence reviewed in the past, calcaneal osteomyelitis focused on the following objectives: bone infection control, dead space and wound management and good functional outcome.<sup>6</sup>

Partial calcaneotomy can be an alternative for leg amputations, under the appropriate conditions. Partial calcaneotomy is thought to be a fairly simple surgical procedure that can remove infected bone. An extensive preoperative workup is encouraged. In our case non-invasive vascular testing was performed, followed by an MRI of the right lower extremity. MRI demonstrated contiguous osteomyelitis of the posterior-inferior calcaneus. MRI is thought to be essential in highlighting the presence and extent of osteomyelitis.<sup>7</sup> Once the preoperative work up was completed the partial calcaneotomy was performed.

Wound closure can be achieved by primary or secondary intention. Plastic techniques can be used if primary wound closure is not possible. Plastic procedures may include free muscle flaps or local flaps. The choice of soft tissue coverage should be based on the size of the soft tissue defect.<sup>8</sup> In our case, soft tissue coverage was not possible. The arc of rotation flaps allows for redistribution of tension from the site of the primary defect to the donor site, as well as provide coverage for larger defects. Thus, a rotational flap was used in our case.

Our surgical approach was enriched using a circular external fixator for stabilization treatment. We designed the external fixation device to stabilize the foot and ankle in an equinus angle. This allowed for offloading of the heel, as well as keeping tension to the flap at a minimum. We know that this approach is not common, but we believe that the application of external fixation should be considered during the reconstructive phase of treating calcaneal osteomyelitis.

Our present case details the successful use of a rotational fasciocutaneous flap with external fixation device in a patient with a chronic wound for about 2-3 years. Patient had previously tried local care, hyperbaric oxygen therapy, and prolonged IV antibiotics with total contact casting with no positive result.

## Conclusion

We present a patient that was statistically bound for a BKA and subsequent morbidity. However, utilizing aggressive wound care, partial calcaneotomy, rotational fasciocutaneous flap and application of external fixation we have been able to bring a BKA and allow this patient to continue ambulating.

In conclusion, this case illustrates an alternative method for treatment of chronic osteomyelitis of the calcaneus. In our case study, the chronic calcaneal wound healed in one month and has remained healed without any recurrence at the six-month mark.

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### INTRODUCTION

- Malignant peripheral nerve sheath tumors (MPNST) make up as much as 10% of all sarcomas in the foot and ankle.
- Of all MPNST they are most commonly found in the foot and ankle 10.2% of the time.
- Definitive diagnosis is determined by biopsy
- Treatment is usually wide debridement or amputation with or without chemotherapy or radiation therapy

### OBJECTIVES / PURPOSE

- This case presentation was written to discuss and educate the reader on malignant peripheral nerve sheath tumors and how a young athlete was successfully treated for it.

### Setting

- Christiana Care Health System, The Foot Care Group, Hospital of the University of Pennsylvania

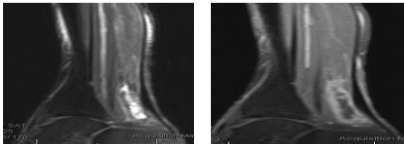
### Methods

- This case report follows the diagnosis and treatment of malignant peripheral nerve sheath tumor in a 27 year old male athlete.

### Patient Presentation

A patient presented to the office with new pain in the left heel at the posterior aspect near the Achilles tendon insertion after playing basketball. The symptoms that he displayed were a 2x3cm mass with edema, and tenderness to palpation near the insertion and watershed of the Achilles tendon. He underwent PRICE therapy and obtained an MRI w/o contrast of the left ankle revealing possible hematoma or stenosing tenosynovitis of the Kager's area with low likelihood of neoplasm. On the T1 weighted pre-contrast 10 cm cranio-caudal 3cm x3cm fluid collection with high signal intensity on T2 weighted imaging and isointense signal intensity to muscle on T1 weighted imaging. The Achilles tendon itself was normal intensity on T1 and T2 weighted imaging. Achilles insertion unremarkable. Non-specific inflammation around medial and lateral ankle. The radiologist recommend an MRI with contrast and the conclusion was unchanged from the pre-contrast MRI. He underwent aspiration of the Kager's triangle where the hematoma was present and had 100 mL of sanguineous fluid aspirated with some relief, but still tender. Patient tried a series of protecting the Achilles with a CAM boot, resting, icing, elevating, ankle bracing and physical therapy without relief. The mass was still present and began to increase in size so it was deemed necessary to excise surgically.

In surgery the mass was found to be rather proximal in the left lower leg and was sent for pathology. The pathology report diagnosed the mass a malignant peripheral nerve sheath tumor (MPNST). The pathology report was found to have the specimen measuring 7.5 x4.5 x3.0 cm weighing 47 grams. Hemorrhage was noted centrally within the mass. Microscopically, it was a high grade spindle cell sarcoma with alternating cellular and myxoid areas suggestive of sarcoma. The specimen was then sent to have an expert opinion for classification of sarcoma. Since synovial sarcoma and rhabdomyosarcomas also display a similar fibrosarcomatous pattern numerous immunostains were performed to rule out the tumor was positive for S100 protein and cytokeratin and negative for desmin and EMA (which are helpful in the differential consultation for the left lower extremity which suggested amputation. However, patient wished to attempt limb salvage and had consultation with a surgical oncologist for management. A CT of the lungs did not show evidence of metastasis. The plan was for pre-op chemotherapy, wound bed excision, followed by radiation therapy. The chemotherapy was 6, 3 week cycles followed by 5 weeks of rest before surgery. During this time he underwent follow up MRI of left ankle. PET scans and CT scans for potential metastasis. He did not show any metastasis throughout this time. He underwent wide resection of the tumor due to possible microscopic contamination and spread during initial excision and free flap closure. He then underwent radiation therapy after surgery. His follow up was 4.5 years later was unremarkable for neoplasm.



### Discussion

Malignant peripheral nerve sheath tumors are relatively rare in the foot and ankle. They make up any where from 2-10% of all sarcomas of the foot and ankle (2, Mann). MPNST are found in the foot and ankle about 10.2% of the time (1). This is in older predilection and the age range for these tumors is usually 30-60 years. Malignant peripheral nerve sheath tumors can have various cell lineages which is partly why they used to be termed malignant schwannoma, malignant neurilemma, neurogenic sarcoma and neurofibrosarcoma until the World Health Organization changed the name to malignant peripheral nerve sheath tumor. Up to 50% of patients with malignant peripheral nerve sheath tumors have neurofibromatosis type 1 and may present with classic "Cafe au Latt-spots (2,3,4). When assessing the mass on physical exam, mobility in the transverse plane without proximal and distal migration of tumor is typical for PNST (3).

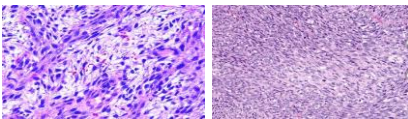
It is important to have a proper work up for these patients and to detect the tumor early, which is often difficult as symptoms are often nondescript and mimic other pathology. Some symptoms may be edema, color, pain around the mass. Imaging can be rather nondescript for these patients as well which can sometimes delay treatment (1-4). X-rays may show soft tissue edema with possible surrounding calcifications in the soft tissue without osseous disruption. MRI is the preferred advanced imaging modality as it can assist in surgical planning and staging. Staging using Enneking classification can help determine prognosis for these lesions (7). On MRI, findings that can determine whether a PNST is malignant or not is size (5-5 cm), deep site, heterogeneous signal intensity on MRI, hemorrhage and necrosis, early and heterogeneous contrast enhancement on MRI, irregular margins, surrounding soft tissue edema and invasion of adjacent structures (9,9). Terms such as "split fat" sign which is a thin rim of fat encompassing the lesion on T1, "ball on string" sign where the nerve can either be entering or leaving the lesion, or "target sign" where peripheral high signal to central low signal on T2 cross section of the lesion may be seen on MRI. (8)

In order to make a definitive diagnosis of MPNST a biopsy is often needed. If biopsy proceeds surgery then core biopsy is preferred over fine needle aspiration so as to not disrupt the capsule and possibly seed the tumor into adjacent tissues. A multidisciplinary approach is recommended when concern for a malignant tumor. Chemotherapy, while controversial, can be considered for patients with a high-grade, large, deep soft-tissue sarcoma 2x-4x. The five-year survival rate after appropriate treatment is 82% to 98% for low-grade large, deep soft-tissue sarcomas, 80% for intermediate-grade tumors, and 52% to 60% for high-grade tumors.

Up to 95% of extremity peripheral nerve sheath tumors require surgery regardless of malignancy or benign (5). Recurrence even after surgical resection is a possibility between 32-63% of the time at mean interval of 32 months. Treatment for these tumors often require wide debridement in order to resect all of the tumor vs radical resection which removes an entire compartment. When resecting the tumor it is important not to disrupt the capsule (10-11). It is also important to keep in mind recurrence, function, the duration and intensity of radiation and chemotherapy needed before and after resection and to some extent cosmetics. Frozen cuts of free tumor margin of at least 2cm is recommended (10,11). Whereas chemotherapy and radiation therapy as adjunct can help prevent recurrence. Radiation therapy has been recommended if the location, size, and distribution of the tumor make it more technically difficult to provide optimal radiotherapy after excision and if there is questionable clear margins. It is also recommended if dissection is anticipated along a major neurovascular bundle (with the possibility of leaving microscopic disease in critical structures) or if remote tissue flaps or skin grafts are required for wound management and there is concern for reduced quality of life after wide resection vs amputation and found that there was no statistically significant difference. (11). It is also recommended to perform sentinel lymph node biopsy to determine possible metastasis (14).

Surgical resection of the tumor is often performed in combination with either chemotherapy or radiation therapy. Radiation therapy is part of standard treatment of soft tissue sarcomas. Helps decrease occurrence. Pre-op radiation can help minimize the field needed for therapy, smaller total dose, and may help survival rate. However, may induce fibrosis making surgery difficult, increased infection rate and wound complication rate. Post-op radiation therapy lower wound complication rate, but may lead to greater chance of long term radiation morbidity. For metastatic tumors it is important to coordinate radiotherapy and chemotherapy in coordination with oncological team (10-13).

MPNST often have poor prognosis compared to other soft-tissue malignancies. The most significant prognostic factor is how well the tumor can be resected. Some poor prognostic factors are soft tissue necrosis, high cellularity, increased mitotic index. Factors with decreased survival rates are high tumor grade, central location, size greater than 5cm, presence of neurofibromatosis, need for amputation for resection and tumor recurrence (15, 16). If MPNST presents in an extremity it often carries a better prognosis. However in one study the disease-specific mortality rate was 43% at 10 years, with a continuously disease-free survival of no greater than 40% (16).



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# Mid-term Outcomes of Endoscopic Debridement for Chronic Plantar Fasciitis: 5 Year Outcomes in 125 Patients

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## Purpose

Plantar Fasciitis(P.F) is the most common cause of heel pain affecting 10% of adults[1]. Conservative measures have proven acutely effective[2], however after 12 months these modalities are often unsuccessful[3]. Surgical treatment involves endoscopic and open, partial to complete releases of the plantar fascia with success rates ranging from 48-90%[3,4,5,7,8]. These treatments have proven successful in the short term however it has been reported that as many as 44.4% have either suffered recurrence or continued pain at 4.8 year follow up[3,5]. Endoscopic plantar fascia debridement has proven effective in the short term with the current study being the first to evaluate the 5-year effectiveness of this innovative technique.

## Methodology

A retrospective review was conducted evaluating patients who underwent endoscopic plantar fascia debridement and heel spur resection between 2011-2014. This study included patients who failed conservative management electing for surgical intervention. Patients with less than 5 year follow up, those where the plantar fascia was released, or had other concomitant procedures were excluded. Post-operatively patients were non-weightbearing for 3 days followed by weightbearing as tolerated in a controlled ankle motion boot for 4 weeks. Physical therapy was initiated at week 3 and patients were transitioned into regular shoe gear after 4 weeks. AOFAS, FFI, and VAS scores were obtained for the 125 patients meeting study criteria. Patients who were not able to present for in-person evaluation were reached via telephone survey. Demographics of all patients are shown in Table 1. Figures 1 shows a condensed version of the surgical process.

Demographics	
# Patients (n)	125
Female	96
Mean Age (years)	52.8 ± 13.67
Mean BMI (kg/m <sup>2</sup> [range])	31.9 (21.4-48)
Laterality, R	72
Mean Duration Symptoms (weeks)	7.4(2-19)

Table 1: Patient demographics

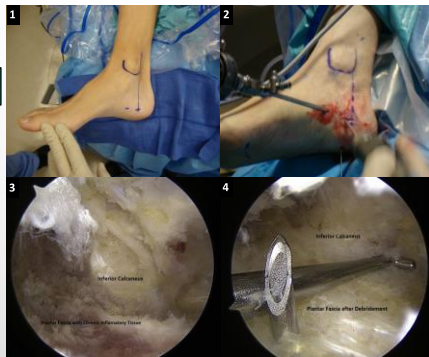


Figure 1: The portals (Image 1) are mapped out medially. Instruments are then inserted with a needle piercing the fascia at the point of maximal tenderness (image 2). The inflamed fascia is visualized (image 3) and debrided (image 4).

Results			
Score	Pre-Operative mean(range)	5-year Follow-up mean(range)	Procedure Again?
AOFAS	57.6(32-78)	89.1(49-100)	Yes No
FFI	89.4(62-97)	13.4(2-27)	122 3
VAS	8.6(2-10)	0.7(0-4)	

## Surgical Technique

In the pre-operative holding area the most painful area of the fascia is identified and marked on the skin with indelible ink. A high tourniquet is used during the procedure for hemostasis. Once prepped the first portal is placed immediately posterior to the medial malleolus at the level of the plantar fascia with the second portal 2 cm distal at the same level. An obturator is then placed in the portals identifying the superior aspect of the fascia. The 4.0mm 30 degree scope is then inserted distally and the 3.5mm shaver inserted in the proximal portal. A spinal needle is then inserted plantar to dorsal at the marked point of maximal tenderness and visualized using the camera. Under direct visualization the inflammatory tissue surrounding the plantar fascia was debrided using a 3.5mm shaver. The calcaneal spur is then visualized and resected using a arthroscopic burr and shaver. The ablator was then used to debride any remaining inflammatory tissue and debulk any hypertrophic tissue. A probe was then used to ensure the fascia was intact. The instruments were removed and portals closed with 3-0 nylon. Patients are then placed in a soft dressing followed by a controlled ankle motion boot and permitted partial weightbearing as tolerated.

## Results

Of the 125 patients 96 (77%) were women and 29 men (23%). Mean age was 52.8 ± 13.67 (range 22-87) years. Mean BMI was 31.86 (21.4-47.98). Mean duration of symptoms prior to presentation was 7.4 weeks (2.0-19.0). Mean visual analog scores (VAS) improved from 8.6 (2-10) to 0.7 (0-4), Foot function index (FFI) scores improved from 89.4 (62-97) to 13.4 (2-27). AOFAS scores improved from 57.6 (32-78) to 89.1 (49-100). Student's t-test was utilized to compare non-categorical variable for patient subjective outcomes. VAS, AOFAS, and FFI were found to be statistically significant (p<0.05). Of the 125 patients, 98% (122/125) were satisfied with the operative outcome and would have the procedure again. Of the 125 patients one suffered recurrence at 48 months post-operatively which was treated conservatively.

## Analysis & Discussion

Surgical options for chronic plantar fasciitis—open, percutaneous, and endoscopic—are based on partial to complete releases of the fascia. Outcomes are varied with success rates as low as 44.5% in patients with BMIs 29.8[7,8]. Reported complications of endoscopic release are persistent pain 5.6%, numbness 4.3%, wound healing problems 1.7%, and superficial infection 0.4%. This procedure, which was previously discussed by Cottom et al[6], demonstrates a minimally invasive approach that has the ability to maintain the function of the plantar fascia via the windlass mechanism. Due to the ability to maintain physiological anatomy and function, there was no evidence of lateral column pain due to the ability of the procedure to leave the plantar fascia intact. By resecting the synovitis (chronic inflammatory tissue) the source of pain has been alleviated. The addition of the ability to resect the plantar calcaneal spur, despite this not being the source of pain, also demonstrates to the patient the “underlying pathology” has been addressed. The presented study shows improvement in patients outcome scores in at 5 year follow up in a patient cohort with an average BMI of 31.9. Endoscopic debridement allows the surgeon to visually inspect the fascia. Limitations of the current study include the retrospective nature, small sample size, and single surgeon/institution procedure.

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## Background

During the push-off phase of gait the GRF is shared mainly by the hallux and the first and second metatarsal heads, these structures together taking 64% of the total forefoot load (1). Limited first ray mobility and high pressure at the first metatarsal head are related to why first metatarsal head ulcerations are the most common (2).

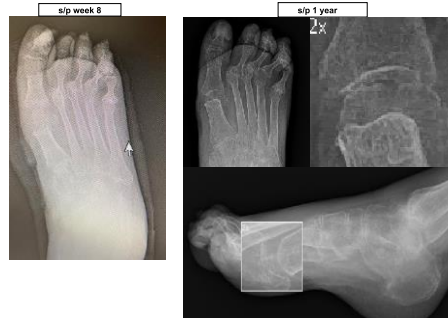
An 11-year retrospective review of 59 patients with partial first ray amputation, reported an incidence of 42.5% (25 patients) of further amputation. Amputation of the hallux greatly reduces the thrust force during the gait, where the hallux with the flexor hallucis longus (FHL) and the flexor hallucis brevis (FHB) play a fundamental role, the absence of which was attributed to rise in peak plantar pressures of the first metatarsal stump and the lesser metatarsal heads(3). The objective of this study is to present a novel way of addressing first metatarsal head osteomyelitis, to maintain the push off phase of gait and to prevent future transfer lesions/ulcerations and ultimately amputations.

## Methods

An Achilles tendon lengthening was performed. The infected first metatarsal head and sesamoids were removed via a separate incision and an antibiotic cement spacer was placed in the area of bony defect. A mini external fixator was applied medially. The plantar wound was debrided as necessary and healed with local wound care in the following post-operative visits. The external fixator was removed once the antibiotic spacer was absorbed.

## Case Study

72 y/o female with a PMHx of DM2, HTN, CAD and positive smoking history was noted to have an infected plantar non-healing wound. MRI suggested osteomyelitis of the first metatarsal head.



## Results

At 1 year follow up, no wound recurrence, transfer lesions, or further amputations were noted. Additionally, maintenance of function and strength of the FHL/FHB were noted, preserving the normal push-off phase of gait. Post operative radiographs showed radio-opacity at the area of bony defect after removal of the antibiotic, suggesting formation of scar tissue and/or endochondral ossification from the bleeding bone after resection. Aesthetically, the presence of the hallux almost preserves the normal anatomic parabola; however, a significantly shortened first ray was noted.

## Conclusion

This approach to address first metatarsal head osteomyelitis proves to be promising. The patient population which develops this pathology are usually not too active, and this procedure will provide them sufficient enough function. Further investigation and assessment of this technique is warranted to display its effectiveness and replicability. This institution has addressed first metatarsal osteomyelitis in this manner on four additional patients, the one year follow up results with assessment of peak plantar pressures are to be reported.

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## PURPOSE

The purpose of this study is to present a case of osteochondroma in the navicular bone with atypical symptoms mimicking posterior tibial tendonitis.

## CASE REPORT

The patient in this case is a 67-year-old male that presented to the clinic with pain in the medial aspect of the left foot. The patient reported having pain during ambulation, walking up the stairs and when plantarflexing and internally rotating the foot. The patient was previously diagnosed with posterior tibial tendonitis by another physician and surgical intervention was recommended. The patient presented to the office looking for a second opinion. He had a history of colon cancer with total resection of the tumor performed 2 years prior, otherwise his medical and surgical history was unremarkable. X-rays were performed, and they showed a bone lesion in the left navicular. Given the cancer history of the patient, total resection of the lesion was recommended. The patient agreed with the plan and the surgery was scheduled.

The surgery was successfully performed (see Surgical Methods) without complications and was discharged home with a posterior splint, which he kept for 4 weeks. Sutures were removed at 3 weeks, and at 4 weeks he began wearing a CAM walker. Patient began weightbearing at 6 weeks and started physical therapy at 4 weeks. Patient achieved full recovery at 3 months post-op, following 4 weeks of physical therapy with painless weightbearing. The patient continues to follow-up every 3 to 4 months to monitor his lower extremities for any new lesions. He remains pain-free in the left foot.



Figure 1. Pre-op

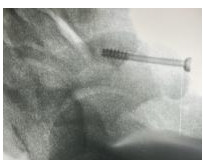


Figure 2. Post-op

## SURGICAL METHODS

Once the patient was accommodated in the operating bed and was placed under general anesthesia, a well-padded ankle tourniquet was placed in the left ankle. An incision was performed in the left medial foot, at the level of the navicular bone, following the direction of the posterior tibial tendon. The incision was deepened down to the bone. Once the navicular was visualized, the navicular tuberosity was separated from the rest of the bone using a sagittal saw and an osteotome. The bone lesion was immediately visualized and was removed using a curette. The navicular bone was debrided using a curette to ensure the complete removal of the neoplasm and the bone defect was filled in with demineralized bone matrix. The navicular tuberosity was reattached using a 3.5 mm screw. The incision was then closed with 4-0 Vicryl and 3-0 nylon. The removed tumor was sent to pathology. Patient was discharged home with a posterior splint, to remain non-weightbearing, and recommended to follow-up in clinic after 1 week post-op.

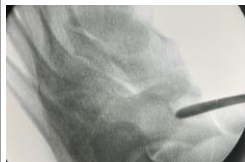


Figure 3. Intraoperative X-Ray



Figure 5. Application of DBM



Figure 4. Clinical intraoperative picture, bone defect after tumor removal



Figure 6. Excised bone lesion

## DISCUSSION

The surgical procedure consisted of complete removal of the neoplasm with thorough debridement of bone tissue to prevent re-growth of the lesion. The navicular tuberosity was removed to gain access to the lesion and then was re-attached using 1 screw. The tendon was tested in the final stage of the surgery and was found to remain intact and fully functional. The removed lesion was sent to pathology and the results indicated that the lesion was benign and consistent with an osteochondroma.

This case study illustrates the importance of reviewing radiographic imaging along with the clinical presentation of the patient. This particular case was previously diagnosed as posterior tibial tendonitis based on clinical symptoms alone. The continuing growth of this tumor could have led to a pathological fracture, or to an eventual malignant transformation.

## LITERATURE REVIEW

Osteochondromas are found to be the most common benign bone tumor in the body. They can occur in various sites throughout the body. Osteochondromas are typically found in adolescents and young adults. Diagnosis is usually confirmed by radiographs or histologically and can allow differentiation into different kinds.

Approximately 10% of osteochondromas occur in bones of the foot and hand despite having a predilection for long bones, such as the tibia, where 15-20% of osteochondromas develop. Though osteochondromas have the potential to undergo malignant transformation, the risk remains as low as 0.6-1% for solitary osteochondromas. Outside of being diagnosed through incidental findings on imaging, patients can present with painless but palpable bony lumps on physical examination.

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# Observed Impact of Skin Substitutes in Lower Extremity Diabetic Ulcers: A Retrospective Analysis of a Medicare Limited Database (2015-2018)

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ASPS 2022

## Introduction

A particularly concerning complication of diabetes is chronic diabetic foot ulcers (DFUs), which affects approximately three million patients annually in the US. Management of DFUs accounts for \$0.6-\$4.5 billion in Medicare spending, rising to \$6-\$18.7 billion when infection management is included.<sup>1</sup> Total Medicare spending for the treatment of DFUs was estimated to be \$6.2-\$18.7 billion annually in 2014.<sup>1</sup> More than half of DFUs develop infection, often with osteomyelitis, and up to 20% of infected DFUs require major or minor amputations.<sup>2,3</sup> The longer a DFU remains open, the greater the risk for infection, osteomyelitis and amputation.<sup>4</sup> In patients with diabetes, 85% of lower-extremity amputations are preceded by a non-healing DFU, and it is estimated that 49-85% of these amputations may be preventable.<sup>5,6</sup> The objective of this investigation of Medicare claims data was to assess the outcomes in patients receiving advanced treatment (AT) with skin substitutes for lower extremity diabetic foot ulcers (LEDUs) versus no AT (NAT) during a treatment episode.

## METHODS

A Medicare Limited Dataset (10/01/2015 - 10/02/2018) was used to retrospectively analyze individuals receiving care for a LEDU treated with AT or NAT (propensity-matched Group 1). AT was defined as high-cost skin substitute products reported under CPT codes 15271-15278 and the applicable Healthcare Common Procedure Coding System (HCPCS) Q-code. The analysis included major and minor amputations, emergency department (ED) visits and hospital readmissions. In addition, AT following parameters for use (FPFU)\* was compared with AT not FPFU (propensity-matched Group 2). A paired t-test was used for comparisons of the two groups. For comparisons of three groups, the Kruskal-Wallis test was used. A Bonferroni correction was performed when multiple comparisons were calculated.

\*FPFU = initiating AT within 30-45 days from the first visit of the episode of care and applying AT within the range of every 7-14 days.

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## RESULTS

There were 9,738,760 patients with a diagnosis of diabetes, of whom 909,813 had a LEDU.

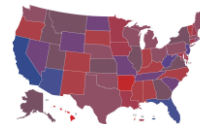
### Criteria applied to identify eligible lower extremity diabetic ulcer (LEDU) patients/episodes

Criteria	Rationale	Number of patients excluded	Number of patients
<b>Meta-group exclusions</b>			
ICD-10 coded diagnosis as a patient with LEDU*	Consensus definition	6,793,926	948,834
LEDU episodes with confirmed diagnosis of diabetes	Consensus definition	—	824,679
LEDU episode started after 31 December 2014		14,866	909,813
<b>Exclusions</b>			
LEDU above the knee only*	Consensus definition	5813	904,000
No defined wound size during run-in period	Study focus criteria	637,061	266,939
Wound depth at the bone during run-in period	Study focus criteria	13,482	263,457
Multiple wounds reported during run-in period	Study focus criteria	63,914	189,543
<b>Exclusions based on timeline complications</b>			
LEDUs outside the defined study period (before 1 October 2015 or ended after 2 October 2018)	Period of the Medicare dataset	23,329	166,214
Episodes that occurred before 1 October 2015	Period of the Medicare dataset	34,427	131,767
Episodes that concluded within 60 days	Not a hard-to-heal LEDU	59,532	72,255
<b>Exclusions based on confounding patient and treatment complications</b>			
Patients receiving hemodialysis (only stage 5)	Confounding comorbidity	8930	62,425
Patients that died within 90 days of the last clinic visit	Confounding comorbidity	5198	57,227
LEDU with no payment or demographic information	Include validated claims	947	56,280
Patients treated with products outside the scope of study	Confounding treatment	1038	54,642
			<b>54,642 Eligible LEDU patients</b>
*ICD-9, ICD-10, ERSD AND ERSD codes were used to include/exclude patients and episodes			

9,738,760 patients

54,642 Eligible LEDU patients

US map of advanced treatment (AT) usage. The usage of AT was calculated by the ratio of AT episodes to no AT (NAT) episodes for each US state and territory. AT:NAT ratios were assigned a color (blue:red) and mapped. Note that within each state individual counties can be different than the state-wide average.



## Key Results:

Result	Propensity-matched Group 1		Propensity-matched Group 2		p-value	
	NAT, n=12,510 Episodes: 12,676	AT, n=12,313 Episodes: 12,676	Paired t-test p-value	NAT, n=1131 Episodes: 1131		Advanced treatment FPFU, n=1131 Episodes: 1131
<b>Visits</b>						
Minor amputations						
n (%)	551 (4.3)	490 (3.9)	0.0374	47 (4.2)	22 (1.9)	51 (4.5)
Rates per thousands	43.47	38.66		41.56	19.45	45.09
Major amputations						
n (%)	402 (3.2)	197 (1.6)	<0.0001	30 (2.7)	<11 (<1.0) <sup>†</sup>	18 (1.6)
Rates per thousands	31.71	15.54		26.53	15.92	15.92
ED visits						
n (%)	2932 (23.1)	2322 (18.3)	<0.0001	237 (21.0)	161 (14.2)	221 (19.5)
Rates per thousands	231.30	183.18		209.55	142.35	195.40
Readmissions						
n (%)	805 (6.4)	508 (4.0)	<0.0001	73 (6.5)	27 (2.4)	39 (3.4)
Rates per thousands	63.51	40.06		64.54	23.87	34.48
Average days to AT (SD)		69.4 (83.3)			34.7 (6.7)	77.2 (86.0)
Average number of AT applications (SD)	0	3.7 (3.6)		0	4.9 (3.8)	3.5 (3.3)

NAT = no advanced treatment; AT = advanced treatment; Episodes = episodes of care; FPFU = followed parameters for use; SD = standard deviation; †Kruskal-Wallis test; (%): AT versus FPFU followed; paired t-test; FPFU followed versus not FPFU followed; p-value; p < 0.11 indicates requiring data manipulation on SAS web site display.

## DISCUSSION

AT for the management of LEDUs was associated with significant reductions in major and minor amputation, ED use, and hospital readmission compared with LEDUs managed with NAT. Clinics should consider implementing AT in accordance with the highlighted parameters for use to improve outcomes and potentially reduce overall healthcare costs.

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\*Paid speaker for MIMED. Poster development supported by MIMED Group, Inc.

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BACK

# Operative Time and Cost of Power Rasp Joint Preparation vs Traditional Joint Preparation in Arthrodesis of the Foot and Rearfoot

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## Purpose

Time spent in the operating room is valuable to both providers and patients. One of the biggest rate-limiting factors when it comes to arthrodesis procedures of the foot and ankle is cartilage removal and joint preparation. The traditional technique of joint preparation includes utilizing osteotomes and curettes to manually debride joint surfaces. Depending on the patient, this can be a very time consuming and arduous task. Childers (1) performed a study in 2018 comparing total costs of operating room time across several institutions for patients in California from 2005-2014. He concluded that the total approximate cost of 1 minute of operating room time was \$37, with a range of \$30-38. Power instrumentation provides an avenue to decrease joint preparation time, thus decreasing operating room time and costs.

## Methodology

An analysis of joint preparation time and cost was conducted on patients undergoing arthrodesis procedures in the foot and rearfoot from 2019-2022. Arthrodesis of 49 joints (n) from 27 patients were included. Joints examined consisted of subtalar joint, talonavicular joint, calcaneocuboid joint, and 1<sup>st</sup> tarsometatarsal joint. Power rasp joint preparation was performed in 37 joints and was compared to traditional osteotome and curette joint preparation of 12 joints in both time (seconds) and cost (total operating room time cost per minute). Demographic data including age, gender, and BMI were also reviewed.

## Demographics

# of patients	27
# of joints (n)	49
Mean Age (years)	61
Mean BMI (kg/m <sup>2</sup> )	32.9
Laterality-R	20 (40.8%)
Female	29 (59.2%)

Table 1: Patient demographics

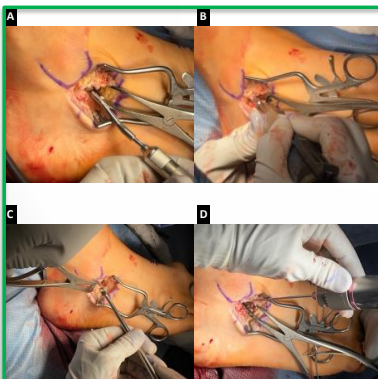


Figure 1: Removal of articular cartilage from the subtalar joint using power rasp (A,B). Removal of loose debris using curette (C). Fenestration of subtalar joint surfaces (D).

## Results

Overall mean joint preparation time using power rasp for subtalar joint 289 seconds, talonavicular joint 249 seconds, calcaneocuboid joint 168 seconds, 1<sup>st</sup> TMT 110 seconds. Mean joint preparation time using traditional method for subtalar joint 536 seconds, talonavicular joint 471 seconds, calcaneocuboid joint 317 seconds, 1<sup>st</sup> TMT 319 seconds. Mean cost of joint preparation using power rasp for subtalar joint \$178.37, talonavicular joint \$153.80, calcaneocuboid joint \$103.60, 1<sup>st</sup> TMT \$67.83. Mean cost of joint preparation using traditional techniques for subtalar joint \$330.53, talonavicular joint \$290.45, calcaneocuboid joint \$195.48, 1<sup>st</sup> TMT \$196.72.

## Results

Joint	Power Rasp Time (sec)	Traditional Time (sec)
1 <sup>st</sup> TMT	110	319
STJ	289	536
TNJ	249	471
CCJ	168	317

## Results

Joint	Power Rasp Cost (\$)	Traditional Cost (\$)
1 <sup>st</sup> TMT	\$67.83	\$196.72
STJ	\$178.37	\$330.53
TNJ	\$153.80	\$290.45
CCJ	\$103.60	\$195.48

## Analysis & Discussion

Proper joint preparation remains a vital step in arthrodesis procedures throughout the body. Increasing efficiency in the operating room is vital to every surgeon's practice. Power rasp joint preparation is a viable option to increase efficiency and decrease operative time. Various authors have explored the importance of proper joint preparation for arthrodesis in the foot. Patel et al performed a cadaveric study in which the subtalar joint was divided into four quadrants. He found that the medial quadrants were more likely to have unprepared cartilage, as well as more inexperienced surgeons leaving a greater percentage of cartilage intact. Additional studies could be performed to analyze the proportion of joint cartilage effectively removed using power rasp versus traditional techniques as well. Avoiding delayed or non-union is also one of the most studied outcomes of arthrodesis procedures. Anecdotally, the authors have not seen a difference in union rate between the two techniques, however future studies could benefit from exploring union rates further.

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### Purpose:

This study analyzed calcaneal inclination angle and talonavicular coverage angle over a collected series of data from 61 patients with a follow up from 5 years to minimum of 6 months

All patients in the study were diagnosed with stage IIB Posterior tibial tendon dysfunction

Literature review was also conducted for talonavicular coverage angle and calcaneal inclination angle improving after osteotomy

It was hypothesized that there would be a significant improvement in calcaneal inclination angle and talonavicular coverage angle with use of a medial displacement calcaneal osteotomy (MDCO)

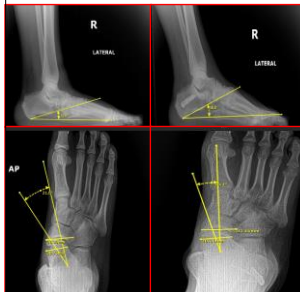
### Methods:

The data was collected from 2017-2021 with 5 years to minimum 6 month follow up

The difference between radiographic angles before and after surgery were calculated by obtaining weight bearing radiographs.

Pearson's chi square test and statistical significance was obtained via GraphPad.

Figure One: comparison pre-op and pos op of weightbearing films of CIA and TN coverage angles



**Procedure:** All patient's placed in lateral decubitus position. Incision made overlying lateral aspect of calcaneus. Deepened to bone reflecting all soft tissue. Osteotomy created with sagittal saw. Plate embed where the calcaneus moves approximately 10mm, and then the plate is permanent fixated. Patient were then followed in the post operative course.



Figure Two: surgical technique intra-op

### Results:

35 female and 26 male for a total of 61 patients, where 9 were bilateral after a year, giving a total of 70 procedures. The Mean age of the cohort was 48 years old.

Zero complications related to the procedure or fixation.

34 had also a flexor augmentation performed

18 had gastrocnemius recession performed.

1 had first MPJ arthrodesis fusion performed

1 had first MPJ arthroplasty performed

3 had deltoid repair performed

We excluded 5 patients due to adjunct procedures such as an Evans and medial column fusion

	Pre-op Average	Post-op Average	P value	Standard Deviation
TN coverage angle	23.86	14.315	<0.0001	0.713
CIA	13.795	18.934	<0.0001	0.274

Table One: Pre-op and Post-op values of TN and CIA averages

### Literature review:

There is very little literature on single osteotomy for posterior tibial tendon dysfunction stage IIB.

Ebaugh et al reported in 2020 in the foot and ankle international on extended Z-cut osteotomy with screw fixation on total of 16 patients and were able to report improvement in calcaneal inclination angle and talonavicular coverage angle with a P-value of <0.001 and 0.05 respectively. He did however report 2 complications.

Myerson did report on performing a double osteotomy on the calcaneus for posterior tibial tendon dysfunction and, Silva et al reported in 2015 in the foot and ankle international on treating posterior tibial tendon dysfunction stage IIB and showed improvement in calcaneal inclination and talonavicular coverage angle with a p-value <0.001 for both. However, she stated she did not have a control group where she would be able to compare a medial calcaneal osteotomy vs a lateral column lengthen. This study was able to provide the control group

### Conclusion:

Strong correlation noted between calcaneal inclination and talonavicular coverage angles p <0.0001

A single osteotomy such as a Medial Displacement Calcaneal slide osteotomy provides correction in Stage IIB posterior tibial tendon dysfunction patients. The findings of this case series can be used for further research.

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# Reconstruction of the Medial Malleolus with Iliac Crest Autograft after Traumatic Loss: A Rare Case Report

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## Introduction

- Traumatic ankle fractures with complete loss of the medial malleolus are rare and are sparsely described in the available literature.
  - Available articles describe variable operative techniques including reconstruction with iliac crest autograft, vascularized fibular head, uncemented 3D-printed prosthesis, and bone-sliding technique.
  - The purpose of this study is to provide a beneficial surgical technique for reconstruction of severely comminuted medial malleolus fractures.
- Fractures of the ankle occur with an annual incidence 4.22 per 10,000 person-years<sup>1</sup>. The talocrural joint is a hinge synovial joint consisting of the distal tibia and fibula, talus, and multiple ligaments. These structures act in a coupled fashion to provide a stable joint that adapts to ground reactive forces and aids in propulsive gait<sup>2</sup>. Failure of either bony or ligamentous structures may lead to abnormal kinematics, thereby increasing joint contact forces and ultimately leading to accelerated post-traumatic osteoarthritis<sup>3-5</sup>.
  - Ankle fractures with complete loss of the medial malleolus are seen infrequently. Due to the rarity of this injury, reconstructive techniques are sparsely described in current literature<sup>6-13</sup>. Available articles describe variable operative techniques including reconstruction with iliac crest autograft<sup>6, 8, 10</sup>, vascularized fibular head<sup>9, 12, 13</sup>, uncemented three-dimensional-printed prosthesis<sup>11</sup>, and bone-sliding technique<sup>7</sup>.

## Case Study

- The presented case is a 19 year-old female who sustained a left open ankle fracture after a workplace incident with complete destruction of the medial malleolus and significant soft tissue loss. Staged fixation was performed with a fine-wire ring external fixator and rotational posterior tibial artery flap. Three weeks later definitive reconstruction was performed using an autologous inner table iliac crest bone graft with direct repair of the deltoid ligament. There were no wound complications and patient progressed to clinical and radiographic union. Patient is now 1 year out from index procedure and ambulating without pain or difficulty.

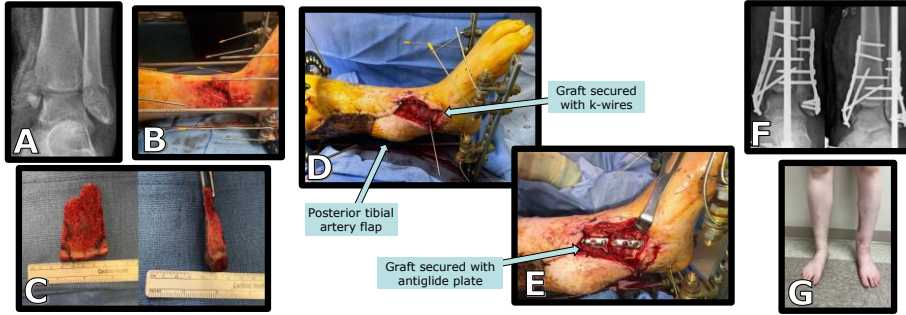


Figure 1. (A) Initial AP view left ankle showing bimalleolar fracture with absent medial malleolus; (B) Medial view left ankle after initial I&D and external fixation; (C) Autologous inner table iliac crest bone graft used for reconstruction; (D) Provisional fixation with k-wires; (E) Definitive fixation with angle plate; (F) Immediate postoperative XR; (G) Patient shown full weight-bearing with well-healed rotational flap.

- The distal fibular fracture underwent open reduction and internal fixation using a plate. To protect the vascular supply of the medial perforator flap, a full-thickness incision was made over the distal anterior and posterior aspect of the flap and the previous incision. Irrigation and debridement was performed, and the articular cartilage of the talus was inspected. A 1 x 0.5cm osteochondral lesion was found at the medial shoulder, was debrided, and microfractured using 1.6 mm Kirshner wire. The medial malleolus deficit was evaluated and measured for graft sizing.
- A 4.4 x 1.9 x 5.3cm autograft was harvested from the iliac crest. The graft was shaped using osteotomes, a burr, and microsagittal saw. Kirschner wires were placed for provisional fixation while alignment and length were checked. An eight-hole antilgide plate was bent in situ and placed to conform to the graft. A rongeur was used to roughen the attachment point for the deltoid ligament on the graft to aid with osseoligamentous integration. The remnant deltoid ligament was identified distally by locating the intact but non-viable colliculus, which was excised. Using #2 non-absorbable suture, the deltoid ligament was secured to the graft by looping one end of each suture through the most distal screw hole in the plate and hand tying with the foot held in generous inversion.

## Analysis and Discussion

- Prior literature contains only two other reports describing reconstruction of the medial malleolus with iliac crest autograft in adult patients<sup>8, 10</sup>, and our case incorporates concomitant direct repair of the deltoid ligament.
- We selected an inner table iliac crest autograft due to the good functional outcomes reported by Kow et. al<sup>8</sup> and Nithyananth et al.<sup>10</sup>. While Nithyananth et al.<sup>10</sup> used two partially-threaded screws to secure their graft, we selected a one-third tubular antilgide plate due to the small size of the graft and superior biomechanical stability in vertical medial malleolar fractures compared to unicortical and bicortical screw fixation<sup>14</sup>.
- In conclusion, open ankle fractures with complete loss of the medial malleolus are rare and can have potentially deleterious consequences. Treatment of this injury with a rotational posterior tibial artery perforator flap, autologous bicortical iliac crest graft, and direct deltoid ligament repair can result in an excellent functional result.

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## Introduction

- Tarsal tunnel syndrome (TTS) is a peripheral neuropathy caused by entrapment of the tibial nerve and its branches in the flexor retinaculum of the ankle in the rearfoot.
- Patients present with symptoms of pain, paresthesia, muscle cramps, and numbness affecting the heel or sole of the foot.
- Diagnosis typically involves association of clinical history, physical exam findings, imaging, and electromyography.
- Forced foot eversion and flexion can exacerbate symptoms. The Hoffman-Tinel test can be positive in >50% of patients with TTS.
- Ultrasound has a relatively high specificity and sensitivity to diagnose TTS based on the longitudinal cross-sectional area of the tibial nerve.
- However, there is reluctance to use ultrasound because of high operator dependence and concern of a steep learning curve.

## Purpose

- Understand how (and to what extent) experience level affects inter-rater reliability for volumetric measurements of the tibial nerve on ultrasound.
- Understand how (and to what extent) device resolution affects inter-rater reliability for volumetric measurements of the tibial nerve on ultrasound.
- Understand how accurate diagnostic ultrasound is in determining tibial nerve volume within the porta pedis.

## Methods

**Day 1** – Prior to assessment Raters underwent a 3-hour educational program using two point-of-care diagnostic ultrasound devices (high resolution: SonoSite M-Turbo and lower resolution Butterfly IQ)

- Volume measurements of the tibial nerve were obtained from ten fresh frozen cadaveric limbs beneath the flexor retinaculum, before the bifurcation in the plantar foot.
- Using the Butterfly IQ ultrasound and the SonoSite M-Turbo ultrasound, four raters (2 experienced and 2 inexperienced) measured the diameter of the tibial nerve of each limb.
- Limbs were randomized by a fifth and sixth researcher, deemed as the recorders.
- Rater 1 (experienced), Rater 2 (inexperienced), Rater 3 (experienced), and Rater 4 (inexperienced) randomly chose a limb to begin their assessment with their initial choice of equipment (Butterfly IQ or SonoSite M-Turbo) while recorders documented measurements.
- Once the Raters assessed each limb, equipment was switched between the Raters so that those that started the assessment with the Butterfly IQ now had the SonoSite M-Turbo.
- Raters randomly chose a new limb to begin a second round of measurements, while recorders documented the measurements.
- The switching of equipment and round of measurements occurred twice more for a total of four measurements (2 done by each ultrasound machine) for each limb.

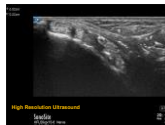


Figure 1: Ultrasound image of a measured tibial nerve using the SonoSite M-Turbo.

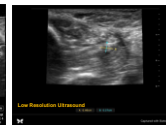


Figure 2: Ultrasound image of a measured tibial nerve using the Butterfly IQ.

**Day 2** – Sonographic values were compared to the dissected measurements obtained using a digital caliper which served as the gold standard.

- The ten cadaveric limbs from the previous day were dissected at the flexor retinaculum using a 10 blade, tissue forceps, and scissors by an anatomist.
- A longitudinal medial incision was made approximately 2 cm below the medial malleolus and 2 cm above the flexor retinaculum.
- The skin was retracted, and the superficial and deep fascia were bluntly dissected. The neurovascular bundle was identified, and tibial nerve dissected.
- Using a digital caliper, the tibial nerve was measured at its widest point in the area of the flexor retinaculum without being compressed.
- Volume was calculated as  $V = \pi r^2 h$ . With  $r$  is (width/2) and  $h$  is depth.
- We assumed that every nerve is cylindrical to compare ICC values.
- Inter-rater reliability and intra-rater reliability were obtained via calculation of Intraclass Correlation Coefficients (ICC) while controlling for the device type and rater experience level.



Figure 3: Locating and measuring the tibial nerve using the SonoSite M-Turbo on cadaveric limb.



Figure 4: Image of dissected tibial nerve being measured using digital calipers.

## Results

Agreement with Gold Standard on Butterfly IQ

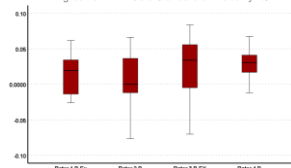


Figure 5: The box plot indicates how close each rater was to the actual measurement of the cross-sectional area of the tibial nerves using the Butterfly IQ ultrasound machine.

Agreement with Gold Standard on SonoSite M-Turbo

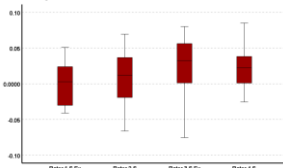


Figure 6: The box plot indicates how close each rater was to the actual measurement of the cross-sectional area of the tibial nerves using the SonoSite ultrasound machine.

	Intraclass Correlation (ICC)	Significance (p-value)
Agreement b/t ALL raters irrespective of experience/equipment	0.901	0.000
Agreement b/t EXPERIENCED raters	0.844	<0.001
Agreement b/t INEXPERIENCED raters	0.796	<0.001
EXPERIENCED raters' agreement b/t equipment	0.947	0.000
INEXPERIENCED raters' agreement b/t equipment	0.928	<0.001

Table 1: Intraclass correlation (ICC) values below 0.5 indicate poor agreement, values between 0.5 and 0.75 indicate moderate agreement, values between 0.75 and 0.9 are considered good agreement, and any value above 0.9 indicates excellent agreement.

## Discussion

- Intraclass Correlation Coefficient (ICC) is a statistical test to quantitatively state how close in agreement each rater is when compared to other.
- The difference between the Gold Standard calculation and measurements done by each rater was used to study the interrater reliability through Intraclass Correlation (ICC) coefficient.
- If the ICC is 1 then there is perfect agreement among the raters. 0.8 or above is considered a strong correlation, 0.5 is considered moderate correlation, while anything less than 0.5 is considered less correlation.
- There was significantly strong agreement (ICC=0.844, p < .001) between the two experienced raters.
- Similarly, there was strong agreement between inexperienced raters as well (ICC=0.796, p < .001).
- No matter which equipment was used, the agreement between raters remained in high agreement (Table 1).
- Time taken on SonoSite for measurement was 77.8(27.5) seconds. Time taken on Butterfly IQ for measurements was 62.8(20.4) seconds. Time taken for raters on each equipment for measurements was not significant (paired T-test, P<0.05).
- 4 raters (2 experienced providers/sonographers and 2 inexperienced student raters) were consistently able to accurately measure the tibial nerve volume to within 5% more than ninety percent of the time, irrespective of equipment type and experience level.
- The widest recorded variation was an underestimation of 8% in both the SonoSite M-Turbo and Butterfly IQ and an overestimation of 10% in the Butterfly IQ and 12% in the SonoSite M-Turbo.

## Conclusion

- With just a short education program, even inexperienced raters using low resolution ultrasound devices can accurately record tibial nerve volume under the flexor retinaculum.
- Results from this study suggest that ultrasound is a quick and reliable tool to help clinicians diagnose tibial tarsal tunnel syndrome.

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# Screening for Suicide Risk in Novel Settings: Podiatrists as Partners in Prevention

## INTRODUCTION

- Patients presenting to podiatric medical/surgical practices often present with risk factors for suicide (e.g., chronic pain, diabetes, debilitating injuries).<sup>1,2</sup>
- The majority of suicide decedents visited a healthcare provider months, sometimes weeks before their death.<sup>3</sup> Therefore, clinicians have an opportunity to identify those at elevated risk and refer them to mental healthcare.
- Specialized physicians, such as podiatrists, are uniquely positioned to detect suicide risk, as they may be one of few regular medical contacts for patients.<sup>3</sup>

## PURPOSE

- Describe the feasibility of implementing suicide risk screening in an outpatient podiatry clinic.
- Describe the benefit of screening for occult suicide risk in novel settings, such as podiatric/surgical settings.

## METHODS/PROCEDURES

**Study setting:** The Wheaton, Maryland Division of Foot and Ankle Specialists of the Mid-Atlantic, an outpatient podiatry clinic/surgery center in the US.

**Sample:** Convenience sample of adult (ages 18 and older) medical outpatients, collected between December 2019 and February 2020.

**Screening Implementation:** Implementation followed the Plan-Do-Study-Act (PDSA) quality improvement framework.<sup>4</sup> All staff completed both online and in-person trainings to review screening procedures.

### Materials:

- All adult patients were screened with the Ask Suicide-Screening Questions (ASQ) tool,<sup>5</sup> a 4/5-item tool to identify patients at risk for suicide (Figure 1).
- Podiatrists assessed patients who screened positive for suicide risk with the ASQ Brief Suicide Safety Assessment (BSSA).
- Clinic staff opinions about the screening process were collected pre and post screening.

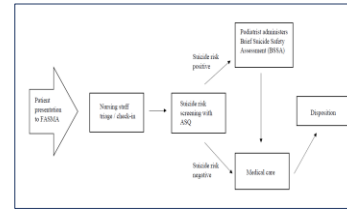
## AFFILIATIONS

This quality improvement project was supported in part by the Intramural Research Program of the NIMH (Annual Report Number ZIAMH002922). The authors have no conflicts of interest to disclose.

## FIGURES

Figure 1: Ask Suicide-Screening Questions (ASQ)

Figure 2: Suicide Risk Screening Workflow



## DISCUSSION

- The 2% screen positive rate was high enough to warrant screening and low enough not to overburden a busy outpatient podiatry practice/surgery center.
- Screening was efficient and effective. The ASQ took approximately 20 seconds to administer, and the podiatrist was able to complete the follow up assessment (BSSA) in less than 5 minutes.
- Staff felt both comfortable and in favor of screening within a specialized medical setting.

## LIMITATIONS

- This study was limited to adult patients.
- It is unknown how many patients visited a mental health professional following their referral.
- Patient outcomes post discharge were not recorded.

## CONCLUSIONS

- In a busy podiatric medical practice, suicide risk screening was feasible and successful.
- Screening with the ASQ provided additional important clinical information that would not have been otherwise detected and led to improved overall patient care.
- Screening patients for suicide risk is a valuable opportunity to take care of our patients as a whole human.
- Podiatrists can be leveraged as important partners in suicide prevention.

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## RESULTS

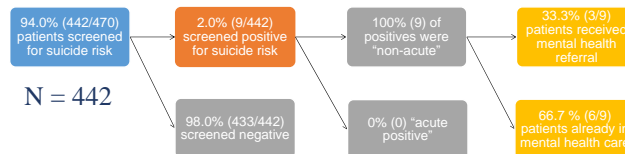
Table 1: Patient Demographics

Demographics	Total (N = 442)
<b>Gender:</b>	
Female	258 (58.4%)
<b>Mean Age:</b>	59.9
Range: 20-98 years	(SD = 19.7)
<b>Race/ethnicity:</b>	
White	242 (54.8%)
Black	126 (28.5%)
Asian	21 (4.8%)
Hispanic	47 (10.6%)
Other	6 (1.3%)

## Staff Opinions and Experiences After Implementing the Screening Program

- All staff members reported NO concerns working with patients with suicidal thoughts.
- All staff members found it acceptable to ask patients about suicidal thoughts.
- 5/5 nurses and 2/3 doctors felt screening should continue in the practice.
  - After the study, the doctor that was “undecided” later endorsed screening for the office.

Figure 3: Screening Outcomes



BACK





# Surgical Management of Functional Hallux Limitus Using Long-Arm Austin with Cotton Osteotomy and its effect on Cuneiform Articular Angle, Medial Arch Sag Angle, and Meary's Angle

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## ABSTRACT

Functional hallux limitus (FHL) is a byproduct of medial column instability secondary to pathologic compensation in the closed-kinetic chain. The literature has documented conservative treatments to correct functional hallux limitus effectively. However, when conventional remedies fail, surgical intervention is indicated. This paper presents a case of failed conservative treatment in a patient with FHL caused by instability of the medial column, specifically at the navicular-cuneiform joint. The Cotton osteotomy was used to improve the medial longitudinal stability. We assess the competency of the medial column by comparing preoperative and one-year postoperative weight-bearing lateral radiographs by utilizing medial arch sag angle (MASA), cuneiform articular angle (CAA), and Meary's angle (1,2) (Figure 4). We noted radiographic correction of the medial column instability with improved CAA, MASA, Meary's angle, MCH, and calcaneal pitch. In addition, the patient demonstrated enhanced foot function at the 1st MPJ with a preoperative metatarsophalangeal-interphalangeal (MTP-IP) score of 62 and a postoperative metatarsophalangeal-interphalangeal (MTP-IP) score of 90. This study emphasizes the importance of preoperative CAA assessments to ensure that the appropriate graft size is utilized to prevent poor patient outcomes. This study also introduced a novel NC fault classification system based on the radiographic and clinical presentation for medial column instability. Finally, treatment options were suggested on the appropriate procedure(s) needed for correction. To the authors' knowledge, this is the first study done to investigate the use of a first metatarsal distal shaft osteotomy with a Cotton osteotomy (OT) and a posterior muscle group lengthening to improve the foot function at the 1st MPJ during gait and the stability of the medial longitudinal arch.

## INTRODUCTION

FHL is the lack of acceptable ROM at the 1st MPJ, while the first ray is loaded in the closed-kinetic chain(3). However, the deformity displays normal motion in the open-kinetic chain, making it challenging to diagnose and treat(4). During the propulsive phase of gait, an adequate ankle ROM and a stable medial column are needed for proper motion at the MPJ, allowing the hallux to properly dorsiflex on the depressed first metatarsal without impingement(5). FHL results from medial column instability occurring at the 1st TMT, NCI, TNI, or simultaneously at all three joints(6, 7, 8). This instability is due to compensation at the subtalar and midtarsal joints from abnormal pronation(9). Studies have shown that significant motion and pathologies in the medial column occur at the NCI(10).

When evaluating a patient with FHL, it is essential to identify the site of the deformity within the medial column, failure to do so will lead to suboptimal results(5). The location of the deformity can be determined clinically with a standard weight-bearing lateral radiograph, reverse Coleman block test radiograph, or a weight-bearing CT scan.

In our study, the competency of the medial column was assessed using weight-bearing lateral radiographs evaluating MASA, CAA, and Meary's angle(1,11). Aiyer et al. described the MASA as the angle between the navicular's proximal articular surface and the first metatarsal's proximal surface (Figure 1A). The MASA is negative when the proximal articular surface of the first metatarsal is plantarflexed compared with the proximal articular surface of the navicular(1). Castaneda et al. (11) described the CAA as the angle between the medial cuneiform's proximal and distal articular surfaces (Figure 1B). The CAA is negative when the distal articular surface of the first metatarsal is plantarflexed compared to the proximal articular surface(20).

The Cotton osteotomy has been used to treat medial column instability by increasing tension across the plantar fascia, stabilizing the longitudinal arch, and improving 1st MPJ ROM during gait(12). These angles are measured on weight-bearing lateral radiographs and can be used to assess the efficiency of the Cotton osteotomy in improving the medial column(13).

To the authors' knowledge, this is the first study to investigate using a first metatarsal distal shaft osteotomy with a Cotton osteotomy, and a posterior muscle group lengthening to improve the foot function at the 1st MPJ during gait and the stability of the longitudinal arch.

Figure 1: Illustration of how the MASA (A), CAA (B) angles are measured.

## CASE PRESENTATION METHODS AND RESULTS

A 53 y/o male non-tobacco smoker presented to the ambulatory surgery center for a painful left foot bunion that had failed conservative treatment. He described the pain as dull and achy to the 1st MPJ, especially when ambulating or running. The patient demonstrated a lateral deviation of the hallux on the physical exam. The ROM to the 1st MPJ on weight-bearing was 0 and 75 degrees off weight-bearing. The Hubsher maneuver reflects a collapse of the medial longitudinal arch on weight-bearing with compensation. The ankle ROM with the left knee extended and flexed was 3 degrees and 10 degrees, respectively, signifying gastrocnemius equinus. A palpable and painful soft tissue mass was noted over the EHL of the 1st MPJ. The neuromuscular examination was unremarkable bilaterally.

The patient's preoperative dorsal-plantar radiographic studies showed a mild left hallux valgus deformity with no other structural deformities noted to the 1st MPJ (Figure 2). The patient was medically optimized for surgical correction of the painful left functional hallux limitus. Attention was directed to the dorsal aspect of the left 1st MPJ, where a 6 cm linear longitudinal incision was made medial and parallel to the EHL tendon. The incision was deepened through the subcutaneous tissues to the capsular layer with sharp and blunt dissection, where an enlarged soft tissue mass was identified (Figure 2C). The mass was resected and sent for pathological evaluation. Then, a classic distal long arch chevron osteotomy was performed to correct the IM angle (Figures 3A and 3B). Next, a Cotton osteotomy was completed to plantarflex the first ray and improve medial column function. In addition, a gastrocnemius recession was performed to improve the ankle ROM.

Postoperatively, the patient was kept in non-weight bearing status for 3-4 weeks and advanced to weight-bearing as tolerated in a CAM walker at six weeks. He then transitioned into a regular supportive sneaker with arch support at eight weeks and was given physical therapy instructions to improve gait, function, and regain strength. When placed in the supportive shoe, the patient demonstrated no pain or difficulty walking. His postoperative course was unremarkable. The patient showed satisfaction and returned to pre-surgical activities, including running, jogging, and walking. Thirteen months later, the patient returned to the clinic extremely satisfied with the procedure, stating that they could return to their previous levels of activity pain-free.



Figure 2: Intraoperative (A) and postoperative (B) antero-posterior weight-bearing radiographs.

Figure 3: Intraoperative pictures. A: Intraoperative incision planning. Note the dorsal bump at the 2nd MPJ. B: Front view of the 1st MPJ from proximal view due to FHL, was appreciated. C: Increased 1st MPJ ROM after Cotton and distal shaft osteotomy.

STAGE	DEFORMITY	IMAGING STUDIES	TREATMENT OPTIONS
1	Mild	The sag is mild or subtle on standard weight-bearing lateral radiographs but evident on reverse Coleman block test radiograph or standing CT scan. Mild CAA and MASA	Cotton osteotomy with 6-8 mm graft or reverse Cotton osteotomy
2	Moderate	The sag is evident on standard weight-bearing lateral radiographs and magnified on reverse Coleman block test radiograph or standing CT scan. Moderate CAA and MASA	Cotton osteotomy with 8 mm graft plantarflexion or reverse Cotton osteotomy
3	Severe w/o arthritis	Collapsage of the medial column with 70% NCI sag (Medial Sag) evident on standard weight-bearing lateral radiograph or standing CT scan. Severe CAA and MASA	Isolated fusion of the NC joint or medial column fusion
4	Severe w/ arthritis	Collapsage and arthritis of the medial column with 70% NCI sag (Medial Sag) evident on standard weight-bearing radiograph or standing CT scan. Severe CAA and MASA	Isolated fusion of the NC joint or medial column fusion

Figure 4: (A) Preoperative and (B) 2-year postoperative weight-bearing lateral radiographs. Note the medial column instability with improved CAA, MASA, and MCH. (A) Preoperative angles: MASA 5 degrees, CAA 23 degrees, Meary's angle 12 degrees. (B) Postoperative angles: MASA 6 degrees, CAA 14 degrees, and Meary's of 27 mm.

Table 1: A Novel NC Fault Classification System.

## DISCUSSION

In this case study, our patient presented with FHL secondary to the instability of the medial column at the NCI with a supraventricular gastrocnemius equinus. It has been shown by studies conducted by Redings et al. that, generally, the NCI contributes to half of the sagittal motion in the medial column(10). In addition to "bumping" findings, numerous kinematic studies have shown that the NCI contributes to 50% of the sagittal motion in a normally functioning foot(14). Additionally, Arnold et al. demonstrated that the activity at the NCI is essential to accommodate propulsion or varying surfaces. The problem arises when the motion of the medial column becomes uncontrolled, leading to pathologies like naviculocuneiform facet syndrome and FHL. To stabilize the medial column and help restore the "tripod" function of the foot, procedures such as the Cotton osteotomy have been utilized as an adjunct procedure(15). Prominent researchers have performed various studies that support the use of Cotton osteotomy. Horne and Johnson completed the Cotton osteotomy on 16 feet. They found radiographic angular improvement in calcaneal pitch with an average of 4 degrees and improvement to the Meary's angle with an average of 14 degrees after performing the Cotton osteotomy(11). Lut and Myerson reported radiographic improvements in Meary's angle, medial cuneiform height, and calcaneal pitch after Cotton osteotomy in 81 feet with AAFD(12). Another study by Chien-Shun Wang et al. demonstrated the improvement in Meary's angle, MASA, and CAA after a Cotton osteotomy with an AOFAS ankle-hindfoot score from 5.7 to 80.2. Kunas et al. showed that the graft dimensions used in a Cotton osteotomy greatly impacted the CAA(16). Each millimeter increase in the graft size corresponded with about 2.1 degrees of change in the CAA, indicating that the surgeon must carefully select the appropriate graft size preoperatively to prevent the chances of overcorrection, which could lead to sesamoiditis and poor patient outcomes(16, 17). In this case, the patient had a corrected CAA of 14 degrees after utilization of a 6mm graft which matches the data presented by Kunas et al. a year after this Kunas et al. findings. Conti et al. evaluated the postoperative CAA after Cotton osteotomies. They found a positive correlation between postoperative CAA and the Foot and Ankle Outcome Score (FAOS)(18). This report also found that patients with a CAA < -2 degrees (moderate plantarflexion) had better clinical outcomes as compared to patients with a CAA > -2 degrees (moderate plantarflexion). They also concluded that the surgeon should be mindful of the proper graft size to prevent poor patient outcomes(18). To the authors' knowledge, this is the first study to investigate the combination of a long-arm Austin, Cotton osteotomy, and a gastrocnemius recession to improve the foot function at the 1st MPJ during gait and stability of the medial longitudinal arch. The competency of the medial column was evaluated preoperatively and postoperatively, utilizing weight-bearing lateral radiographs as well as the measurements of the medial arch sag angle (MASA) as described by Aiyer et al. cuneiform articular angle (CAA) as defined by Castaneda et al., and Meary's angle(1, 11). Our study validated the above authors' findings. We compared the preoperative weight-bearing lateral radiograph to the final postoperative weight-bearing lateral radiograph a year after the procedure. We noted radiographically corrected medial column instability with improved CAA, MASA, Meary angle, MCH, and calcaneal pitch. CAA was the only angle with a significant and direct correlation with Cotton osteotomy graft size, supporting statements made by Kunas et al. This is why we recommended the use of the CAA pre and postoperative when implementing the Cotton osteotomy.

In addition to our findings, we proposed a novel classification to help guide the surgeon's preoperative decision when treating medial column instability with an NC fault (Table 1).

## CONCLUSION

This case study proved that a Cotton osteotomy, distal first metatarsal osteotomy, and a gastrocnemius recession could provide the maximum pain-free function for patients suffering from functional hallux limitus. In combination with the procedures above, we demonstrated that the Cotton osteotomy is a powerful surgical option that improves the CAA, MASA, navicular-cuneiform height, and Meary's angle; this mimics the findings of other prominent authors(11, 12, 13, 15, 19). Furthermore, we concluded that we could significantly improve the CAA when utilizing the Cotton osteotomy because the medial column correction is near the CORA, reducing the need for translation of the osteotomy, thus achieving a better angulation correction. Additionally, we emphasized the need to calculate the CAA preoperatively to ensure the appropriate graft size is utilized to prevent poor patient outcomes due to under or overcorrection. We also recommended using a reverse Coleman block test radiograph or standing CT in combination with standard radiology to assess the location of the insufficiency within the medial column to select the best procedure(s) to reestablish the medial column stability. The patient in this paper returned to pain-free daily activities and demonstrated improved foot function at the 1st MPJ with a preoperative MTP-IP score of 62 to a postoperative MTP-IP score of 90 after a 13-month follow-up.

Although the outcomes, in this case, were significant, more prospective studies with a larger cohort are needed to confirm the efficacy of this novel technique. Additionally, more data is required to verify the accuracy, prevalence, and proper treatment protocol for this article's novel NC fault classification system.

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# The Use of a Synthetic Calcium Sulfate Bone Void Filler in Non-Healing Stress Fractures/Reactions

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## Introduction

Podiatric MRI – confirmed stress fractures and bone contusions often present a clinical challenge, when pain is resolved via off-loading – only to return immediately upon unrestricted ambulation. Without a definitive fracture line to address, standard surgical options are limited

## Objectives

To determine if a minimally-invasive procedure could be utilized to treat symptomatic stress fractures/reactions that did not meet criteria for other commonly utilized techniques for surgical intervention.

## Methods

67 patients were treated in a similar manner when all conservative modalities had been exhausted. This included surgical shoe, CAM boot, brace and/or crutches/knee cruiser. Pre and post operative pain scores and return to pain-free ambulation without off-loading were used to determine a successful outcome.

## Procedures

Outpatient surgical procedures were performed under local anesthesia and sedation. A 1 cm – 3 cm incision was made over the symptomatic location which was marked pre-operatively. Blunt dissection was utilized to gain access to the bone. Visualized was either an incomplete fracture line or an area of osteochondral bone. A 0.035 inch Kirchner wire was used to drill into and around the symptomatic area. The holes were filled with synthetic Calcium Sulfate and the excess removed. The wounds were flushed with sterile saline and skin closed with sutures and/or skin closure strips. Sterile dressings were applied, and the patient was placed in a protective boot (weight-bearing). At two weeks patients were transitioned into a surgical shoe and eventually into normal shoe gear at three or four weeks as tolerated.



MRI showing a stress reaction in the medial cuneiform



Example of injectable Calcium Sulfate

## Case Report

84 procedures were performed on 67 consecutive patients between 2014 – 2020 with an average follow-up of 5.6 years. Success of the procedure was determined if the patient was able to return to pain-free activity at the same level, and shoe gear, as before the onset of symptoms.

## Results

94% (63/67) achieved clinical success in the time frame indicated. 3.0% (2/67) needed more than four weeks to reach clinical success but eventually did without further intervention. 1.5% (1/67) had a subsequent re-injury and needed more traditional internal fixation and 1.5% (1/67) required the use of an external bone stimulator – both eventually achieved clinical success.

## Conclusions

The use of a synthetic calcium sulfate bone filler, in a minimally-invasive technique is an effective method for treating stress fractures/bone reactions in the podiatric setting

## Introduction

Patients who fail to seek treatment after injury often present with more complicated sequelae than those treated immediately. Treatment of these patients is further complicated by certain comorbidities. This case presents a 62 year old female with Non-Insulin Dependent Diabetes and Charcot Neuroarthropathy who delayed care after sustaining a rearfoot and ankle fracture after a fall. Tibiotalocalcaneal arthrodesis is a viable option for end stage rearfoot and ankle deformity, even in cases complicated by delayed treatment, diabetes, and Charcot Neuroarthropathy.

## Charcot Neuroarthropathy

Charcot neuroarthropathy is a rare but serious complication of diabetes, which causes progressive destruction of the bones and joints in the foot, altered biomechanics, and an increased risk of ulceration. The graphic below shows the multifactorial nature of Charcot Neuroarthropathy.



## Case Presentation

62 year old female with Non-Insulin Dependent Diabetes and Charcot Neuroarthropathy who presented to clinic for post-operative office visit after partial 5th metatarsal head resection. She noted a new deformity in her foot after she had a fall. She admits to walking on the foot after the injury but denies any pain due to her neuropathy. She knows the deformity is severe but refuses amputation or other surgical intervention and is only interested in conservative care stating "I'm taking this foot to hell with me." She denied any constitutional symptoms such as nausea, vomiting, fever, chills, shortness of breath, and had no other complaints at that time.

## April 2018- Initial Workup

Physical exam reveals peripheral neuropathy, palpable pedal pulses, no open wounds or lesions, and varus foot and ankle deformity. Radiographs reveal a comminuted talus fracture and confirm the severe varus foot and ankle deformity. Surgical intervention was recommended, however, the patient was lost to follow up because she was caring for her terminally ill husband.



## June 2020- Stage 1

The patient, whose husband had since passed away, returned to clinic 2 years later for definitive treatment. Physical exam reveals an even more severe varus foot deformity with a lateral ankle ulceration. Radiographs reveal the foot has medially dislocated on the leg with further talus comminution. She is admitted to the hospital for IV antibiotics and the first of a two-stage procedure. The foot was realigned, and she was placed in a delta frame external fixator.



## July 2020- Stage 2

The patient was taken back to the operating room for definitive treatment. Anterior and lateral incisions were utilized, allowing for excellent exposure of both the ankle and subtalar joints. The joints were adequately prepped and a tibiotalocalcaneal arthrodesis was performed utilizing an anterior plate. The previous ulceration did not allow for primary closure, so a wound vac was applied laterally. She was instructed to be non-weightbearing and to follow weekly in clinic for wound care and radiographic evaluation.



## Conclusion

In September 2020, her wound had completely healed, her foot remained in proper alignment, and she returned to normal shoe with the aid of an Arizona brace. She now only follows in clinic for routine diabetic foot care.

Neglected rearfoot trauma presents a unique and complex set of challenges, especially in the presence of diabetes and Charcot Neuroarthropathy. Tibiotalocalcaneal arthrodesis is a viable treatment option in these patients, even those with end stage deformity. Although there are a variety of adequate surgical techniques and materials available to surgeons, proper surgical planning and patient education remain crucial in the success of the procedure and improving patient outcomes.

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# Tissue Selective Ultrasonic Debridement with Cryopreserved Human Skin Allograft to Heal a Chronic Wound: A Case Report

## Introduction

Venous leg ulcers are a costly health problem that provide significant morbidity, have poor prognosis, and are associated with high healthcare costs worldwide. In the United States, it is estimated that the prevalence of venous leg ulcers is 600,000 annually and cause the loss of 2,000,000 working days per year.<sup>1</sup> The overall prognosis for venous leg ulcers is poor. Only 30% of the venous leg ulcers are expected to heal after 1 month, with 20% of the ulcers remaining open after 2 years, and 8% remaining open at 8 years.<sup>2</sup> It is estimated that the annual United States payer burden is \$14.9 billion globally for venous leg ulcerations.<sup>3</sup> Thus, venous leg ulcerations require a swift and coordinated plan of action.

The current standard of care for venous leg ulcerations includes sharp surgical debridement, well-timed revascularization, venous ablation, infection control, offloading, and compression.<sup>4</sup> Despite these efforts, closure rates for chronic wounds range from 21-35% with high recurrence rates.<sup>5</sup> In chronic wounds, biofilm is a significant obstacle to overcome in effective wound care. Chronic wounds are more susceptible to biofilm formation than acute wounds. Previous studies have shown that 60% of chronic wounds contain biofilm, whereas only 6% of acute wounds contained biofilm in tissue samples.<sup>6</sup> Biofilm can be defined as a microbial colony encased in a polysaccharide matrix that can become attached to a wound surface.<sup>7</sup> Biofilms are regulated by a quorum-sensing system and a cell density-dependent gene expression mechanism that can protect cells from antibiotics, analgesics, and host immunity.<sup>8</sup> Biofilms can also release planktonic bacteria causing a persistent infection.<sup>9</sup> Thus, removing biofilm is both difficult and integral. Strategies to remove biofilm without destroying the surrounding healthy tissue are constantly evolving.

Recently, debridement using ultrasonic waves has been introduced as a new method of treating chronic wounds. Ultrasonic debridement devices work through acoustic streaming and cavitation. Acoustic streaming is a steady mechanical force directed in fluid medium such as sterile saline.<sup>10</sup> Cavitation is theorized to be the formation of gas bubbles in the fluid creating micro-shockwaves.<sup>11</sup> Ultrasonic debridement is thought to include debridement of nonviable material, destruction of bacteria, and an ulcer healing stimulator effect.<sup>12</sup> Once the biofilm is removed and the wound bed is adequately prepared, human skin allografts and biological wound dressings may aid in healing.

TherSkin (Moxon) is a cryopreserved split thickness allograft produced from donated human skin.<sup>13</sup> It is indicated for diabetic foot ulcers, venous leg ulcers, pressure ulcers, surgical debridement, reconstructive fasciitis, traumatic burns, and radiation burns.<sup>14</sup> Human skin allografts have been used for decades, but improvements in the processing of cryopreserved human skin allografts have raised the standard by preserving the native structure and content.<sup>15</sup> TherSkin is different from acellular products from human skin that are decellularized. The decellularization process removes native growth factors cytokines, an induces collagen scaffold cross-linking.<sup>16</sup> One study suggested that TherSkin may provide equivalent or superior outcomes to Autograft (autoprocesses) while reducing the cost.<sup>17</sup>

This study highlights the use of tissue selective ultrasonic debridement in combination of cryopreserved human skin allograft to successfully heal a chronic wound. Ultrasonic debridement and cryopreserved human skin allograft have been documented in the literature individually. This case presents the first reported use of operative debridement using SonicOne (Moxon) and application of TherSkin graft has not been documented in literature.

## Case Study

A 69-year-old female with a history of hypertension, hyperlipidemia, gastroesophageal reflux disease, and chronic venous insufficiency that presented with an ulceration measured to be 6.4 cm x 4.6 cm x 0.1 cm located at the lateral distal left leg (Figure 1). The wound was just proximal to the lateral malleolus. The wound extended through the level of the subcutaneous tissue with fibrinous slough. The wound had surrounding erythema. There was serous drainage from the wound with no maldox. The wound did not probe to bone, tunnel, or undermine. She had 2+ pitting edema to the left leg. She had inflamed varicose veins to the left leg. Multilayer compression dressing was used to reduce the edema and control the underlying venous disease. Patient was prescribed loxoprofen 500 mg po due to suspected Pseudomonas infection.

Treatment included weekly debridement at the wound care center with application of a multilayer compressive dressing consisting of ColliGesse SAH711, ointment (Dinith-Hepnev), topical gentamicin, Cuimed Sorbact (SGN Medical), and dressings (Staccobond) admorbed pads.<sup>18</sup> Elevation of the left leg was encouraged to reduce edema. She eventually received multilayer compression and debridement due to pain. Treatment was continued for 1 month. There was no improvement in the wound with persistent pain to the left leg (Figure 2). At this point, it was recommended the patient undergo surgical debridement in the operating room under anesthesia with application of a biological graft.

Operative findings included thick yellow fibrinous material across the wound bed. The ulceration measured 6 cm x 3.0 cm x 0.2 cm. Ultrasonic debridement was used to excisionally debride the ulceration down through the level of the subcutaneous tissue. The post-operative debridement measurement was 7 cm x 3.5 cm x 0.2 cm. Due to the depth, a TherSkin graft was applied to the area, which was secured in place with sutures (Figure 3). Dressing was applied with Adaptic, 4 x 4 gauze, ABD, wetrol, and coban.

She continued to follow-up at the wound care center with continued treatment. Two weeks post-op, the graft was removed, and the wound was debrided (Figure 4). Four weeks later, TherSkin graft was re-applied to the wound (Figure 5). Three more applications of TherSkin grafts were applied. The wound continued to decrease in size with continued treatment of debridement and multilayer compression (Figure 6). Ten months after her initial visit, the wound was fully epithelialized (Figure 7).

## Figures



Figure 1. Lateral wounds of the distal left leg, which were the patient's first wounds, February 29, 2021.



Figure 2. No improvements noted, March 12, 2021.

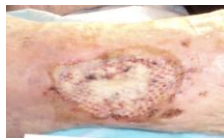


Figure 3. Immediately after OR visit, March 17, 2021.



Figure 4. 4 weeks post-op, April 2, 2021.

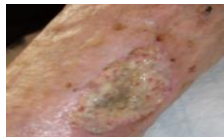


Figure 5. Presentation before TherSkin was re-applied to the wound, April 30, 2021.

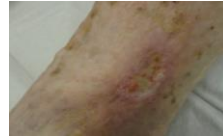


Figure 6. Wound continued to decrease in size, August 20, 2021.



Figure 7. Full healing, December 17, 2021.

## Discussion

Lower limb chronic ulcers are a common frequently occurring disease. Venous leg ulcers are the most common wounds seen in patients.<sup>19</sup> An important aspect of treating ulcers is to assess for infection and biofilm. Local care is the first step in the treatment of ulcers. Key elements to treatment include debridement of biofilm, elimination of serous infection, and moisture balance.<sup>20</sup> Wound dressing selection is a very delicate, but critical part of treatment. The main treatment is compression application.<sup>21</sup> Our patient presented with a venous wound at the lateral distal left leg. The wound showed clinical signs of infection and biofilm present. Patient was prescribed antibiotics for infection control and multilayer compression was applied to reduce edema. In this specific case report, coban was used. The compression allowed for removal of waste products, decreased vasoconstriction, increased arterial perfusion, and allowed for an increase in the delivery of nutrients and oxygen.

Debridement is considered a key element of wound healing and can be defined as the removal of non-viable material, foreign bodies, and poorly healing tissue from wounds.<sup>22</sup> While there are many methods of debridement, we initially started with sharp debridement and chemical debridement. The aim for our weekly debridements was removal of non-viable tissue and slough to reduce biofilm and enhance healing. Our wound dressing of choice was ColliGesse SAH711, ointment (Dinith-Hepnev), gentamicin, Cuimed Sorbact, dressing, abdominal pads and coban. ColliGesse SAH711 ointment contains enzymes so it can remove biofilms as well. Topical gentamicin was used due to signs of infection. Cuimed Sorbact is a bacteria binding dressing and drawtex was used to manage wound exudate. In our case, the patient complained of pain and discomfort. Without improvement for 1 month, ultrasonic debridement in the operating room was recommended.

The clinical effects of ultrasonic debridement as mentioned earlier can provide debridement, a bactericidal effect, and an ulcer healing stimulator effect.<sup>23</sup> Several studies have compared ultrasonic debridement to sharp debridement. In a randomized, prospective, controlled trial, Alvarez et al. showed that wound debridement for venous wounds with ultrasound heated faster, involved less procedure time than sharp debridement.<sup>24</sup> Other authors concluded ultrasonic debridement to be quick, painless, clinically effective and that a subgroup of wounds will go on to complete healing without the need for any additional treatments.<sup>25</sup> Our goal with ultrasonic debridement was to disrupt the biofilm. Once biofilm has been removed, wounds are still difficult to close by primary intention. When considering ultrasonic debridement, a wound closure plan should be highly examined. In our study, we planned for multiple applications of grafts, specifically TherSkin.

Our case included debridement of an infected wound that was considered slow healing. We performed ultrasonic debridement and placement of graft. This allowed for an excellent source of wound bed preparation before placement of the graft. We decided to use TherSkin due it being minimally manipulated, maintaining the natural extracellular matrices, native growth factors, and viable cells. In addition, graft contains biological active proteins and viable cells that accelerate wound healing through generating growth factors and cytokines.<sup>26</sup> Multiple applications of TherSkin were used. The wound continued to decrease in size and eventually healed.

Our case report is the only reported case in literature that we found in which the use of tissue selective ultrasonic debridement in combination of cryopreserved human skin allograft to successfully healed a chronic wound. We believe that this method can improve clinical efficacy and promote healing of chronic ulcers. The results of this study are promising to wound healing and warrants further studies.

## Conclusion

Venous leg ulcers are challenging to treat. Wounds often become colonized with inhibiting their ability to heal. Persistent pain may preclude the ability to perform debridements without analgesia. Tissue selective ultrasonic debridement is one tool available to remove biofilm and prepare wounds for application of advanced tissues to optimize wound healing.

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# Tri-Layer Amniotic Membrane Allografts Support Cell In-Growth and Promote Angiogenesis: Therapeutic Potential for Acute and Chronic Wounds

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ASPS, November 2022

## INTRODUCTION

Restoration of vasculature via specific angiogenic mechanisms, is essential for adequate healing of acute and chronic wounds, whereby, oxygen and nutrients are supplied to the wound and waste products are removed.<sup>1</sup> Treatment of acute and chronic wounds with amniotic membranes resets the wound healing cascade, leading to improved clinical outcomes, and recent research has uncovered its role in regulating angiogenesis.<sup>2-4</sup> This study evaluates the angiogenic properties of a novel tri-layer lyophilized human amnion choriomembrane (LHACM), containing the amnion, intermediate and chorion layers. The effect of LHACM on angiogenesis was evaluated in both *in vitro* and *in vivo* systems.

## MATERIALS AND METHODS

**LHACM Extract Preparation:** Amnion and chorion layers from human placentas were processed using a proprietary gentle cleansing process, and lyophilized under controlled conditions. Soluble factors from LHACM were extracted in assay-appropriate Basal media at 4°C for 24 hours.

**Identification of angiogenic factors:** The presence of angiogenic factors was evaluated in LHACM extract (n = 5 LHACM donors). High Performance Lumines Assays (R&D Systems) were used for identification of angiogenic factors in LHACM extracts, according to the manufacturer's instructions. Each sample was tested in duplicate.

***In vitro* cell invasion:** Endothelial cell invasion was evaluated using the IncuCyte® Chemotaxis Cell Invasion Assay (Sartorius). Human microvascular endothelial cells (HMEC1) were combined with Reduced Growth Factor Matrigel (Corning) and added to the IncuCyte® view insert. The Matrigel was allowed to polymerize at 37°C for 45 minutes. LHACM extract was used as the chemoattractant and added to the wells of an IncuCyte® Clearview reservoir plate (n=3 LHACM donors). Basal media (MCDB 131 medium containing 1% Gluta-gro, and 1% penicillin streptomycin) and complete media (MCDB 131 medium containing 1% Gluta-gro, 1% penicillin streptomycin, 10% fetal bovine serum, 10 ng/mL EGF, and 1 µg/mL hydrocortisone) were used as the negative and positive controls respectively. Assay was conducted at 37°C 5% CO<sub>2</sub> for 24 hours. Invasion was assessed by quantifying total area of 'objects' (cells) located on the top surface and the bottom surface of the Clearview membrane. Automated image processing was performed with the Chemotaxis Analysis module (Sartorius, version 2019B REV2). The metric of 'Total Phase Object Area Normalized to Initial Top Value' was calculated at each time point by dividing the total area of cells on the bottom surface of the membrane by the initial cell area of the top surface of the membrane.

***In vivo* mouse model:** Female and male NU/J athymic nude mice were implanted with 50 mg PECM into a 1 cm x 1 cm surgical pocket. Mice were euthanized at 1, 2, and 4 weeks post implantation. The implant sites were harvested en bloc with 10 mm tissue margins to include epidermis, dermis, muscle, and other surrounding soft tissues. Samples were fixed in 10% neutral buffered formalin for at least 12-24 hours, then transferred into 70% ethanol. Samples were paraffin-embedded and sections stained for Hematoxylin and Eosin (H&E). H&E slides were reviewed and scored by a histopathologist at Stages 0-4.

Angiogenic Response	Implant Response
0: No angiogenesis	0: No implant
1: Minimal <25% implant neovascularization	1: Minimal dermal band and/or minimal dermis within implant material
2: Moderate <50% implant neovascularization	2: Moderate dermal band and/or moderate dermis within implant material
3: Moderate to severe >50% implant neovascularization	3: Moderate to severe dermal band and/or moderate to severe dermis within implant material
4: Marked >75% of implant neovascularization	4: Marked dermal band and/or marked dermis within implant material
Cellular Infiltration/Ingrowth	Implant Response
0: No implant	0: No implant
1: Minimal infiltration, cells present in <25% of implant mass or material layers	1: Minimal dermal band and/or minimal dermis within implant material
2: Mild infiltration, cells present in 25% to <50% of implant mass or material layers	2: Mild dermal band and/or mild dermis within implant material
3: Moderate infiltration, cells present in 50% to <75% of implant mass or material layers	3: Moderate dermal band and/or moderate dermis within implant material
4: Marked infiltration, cells present in >75% of implant mass or material layers	4: Marked dermal band and/or marked dermis within implant material

**Immunofluorescence:** Immunofluorescence was performed on formalin-fixed paraffin-embedded sections. Briefly, sections were deparaffinized, subjected to antigen retrieval followed by blocking in Serum-Free Protein Block (Agilent Dako) for 1 hour at room temperature. Incubation with primary antibody against human-specific collagen type IV, mouse-specific collagen type I, and CD31 in Antibody Diluent (Agilent Dako) was carried out overnight at 4°C. For visualization, cells were incubated with Goat anti-Mouse IgG (H+L) Highly Cross-adsorbed Secondary Antibody, Alexa Fluor™ 488 and Goat anti-Rabbit IgG (H+L) Highly Cross-adsorbed Secondary Antibody, Alexa Fluor™ 547 (Thermo Fisher) and DAPI (Vector Laboratories) to identify the nuclei. Images were acquired on a Leica microscope fitted with x10 and x40 objectives, using Leica Application Suite Advance Fluorescence software and the THUNDER Imager (Leica Microsystems).

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## RESULTS

### LHACM contains pro-angiogenic factors and promotes endothelial cell invasion

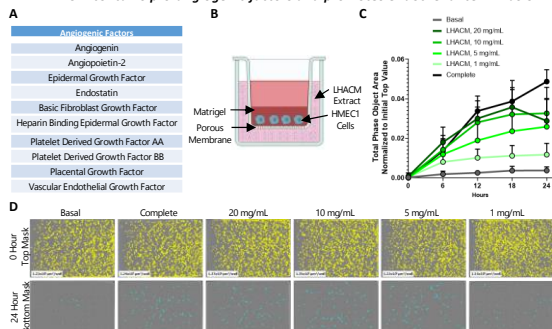


Figure 1. Angiogenic properties of LHACM. (A) Angiogenic factors identified in LHACM extract. (B) Schematic representation of the *in vitro* cell invasion assay. (C) Graphical representation of the total phase object area of bottom normalized to initial top value from 0 to 24 hours. (D) Representative images at 0 hour and 24 hour highlighting the total object area of the top (yellow) and bottom (blue) of the porous membranes used for the invasion assay.

### *In vivo*: Progressive host cell infiltration/ingrowth of LHACM with extensive reorganization and neocollagen deposition

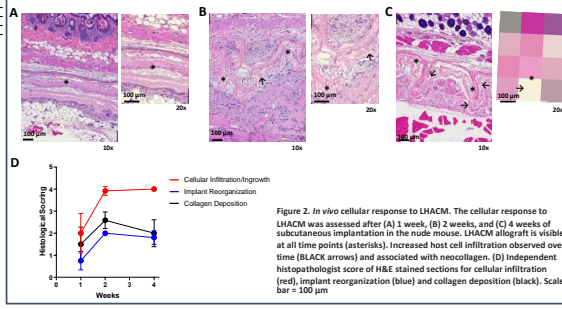


Figure 2. *In vivo* cellular response to LHACM. The cellular response to LHACM was assessed after (A) 1 week, (B) 2 weeks, and (C) 4 weeks of subcutaneous implantation in the nude mouse. LHACM allograft is visible at all time points (asterisks). Increased host cell infiltration observed over time (black arrows) and associated with neocollagen. (D) Independent histopathologist score of H&E stained sections for cellular infiltration (red), implant reorganization (blue) and collagen deposition (black). Scale bar = 100 µm

## RESULTS

### LHACM reorganization and neocollagen formation associated with infiltrating host fibroblasts

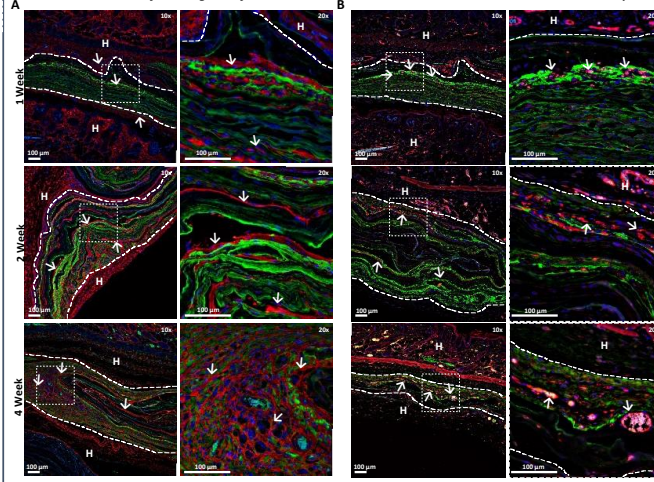


Figure 3. Host cell infiltration in response to LHACM post *in vivo* implantation. LHACM after 1 week, 2 weeks, and 4 weeks of subcutaneous implantation in the nude mouse; 20x (left) and 20x (right). (A) Reorganization and neocollagen formation associated with infiltrating host fibroblasts (arrows). Immunofluorescence of cellular infiltration and associated neocollagen formation: human collagen type IV (green); mouse collagen type I (red); cell nuclei (blue). (B) Recruitment of endothelial cells and neovascularization within the LHACM implant (arrows). Immunofluorescence of endothelial cells: human collagen type IV (green); CD31 (red); cell nuclei (blue). H: host tissue; Scale bar = 100 µm

## CONCLUSION

PURION-processed LHACM retains regulatory factors native to the amniotic membrane, several of which are established pro-angiogenic cytokines. The results of the *in vitro* and *in vivo* experiments demonstrate that LHACM has the potential to promote angiogenesis in chronic wounds and to facilitate host cell in-growth, highlighting LHACM as a promising wound dressing that, while providing a protective barrier, may also support the healing process through enhanced granulation tissue formation within various acute and chronic wounds.

## ACKNOWLEDGEMENTS

*In vivo* study was conducted at Global Center for Medical Innovations (Atlanta, GA). Histological assessment of the *in vivo* study was conducted by StageBio (Freddick, MD).

\*MIMEDIFFIC™: MIMEDI Group Inc. Marietta, GA. PURION® Process, MIMEDI Group Inc., Marietta GA. All authors are employees of MIMEDI Group, Inc.



## Two-Year Outcomes After Total Ankle Replacement with a Novel Fixed-Bearing Implant by a Single Surgeon Non-consultant or Inventor

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### Purpose

Total ankle arthroplasty (TAR) continues to gain popularity amongst surgeons and patients as an alternative to arthrodesis. Historically the designs of early implants were plagued with complications and frequently abandoned. Since that time the procedure and materials have undergone significant advancements in both surgical approach as well as design and function of the available implants.

### Methodology

36 patients who received a semi-constrained prosthesis with a unique fixed bearing polyethylene were identified. Minimum follow up was two years. Demographic, social, and past medical data was retrospectively reviewed. Concomitant procedures were also recorded. Radiographic analysis included the tibiotalar angle, tibial axis-talar ratio, as well as peri-implant subsidence and cyst formation. Clinical outcomes included VAS and AOFAS scores.

### Demographics

# of patients (n)	36
Female	15 (41.7%)
Mean Age (years)	68.9
Laterality-L	17 (47.2%)
Mean BMI (kg/m <sup>2</sup> )	33.6

Table 1: Patient demographics

### Surgical Technique

All total ankle arthroplasty procedures begin with a standard anterior ankle incision between the tibialis anterior (TA) and extensor hallucis longus (EHL) tendons down to retinaculum. The retinaculum is incised. The neurovascular bundle is retracted laterally and TA tendon medially. A periosteal incision is made and the ankle joint exposed. Prophylactic medial malleolar screws are placed to prevent stress fracture. The tibial cutting block is positioned and confirmed under fluoroscopy. Tibial resection ensues. Hintermann distractor placed medially to distract ankle joint. Remove remaining tibial cut. Apply talar cutting block. Make sure block is as distal as possible and ankle at 90°. Fix ankle with medial and lateral pins. Resect talar dome. Assess size of tibial component. Resect posterior, medial, and lateral talus. Ensure there is at least 2mm margin medially and 1-3mm laterally. Ream anterior talus. Trial both the tibia and talus. Once sizes confirmed, the anterior talus must be cut utilizing power rasp. Drill peg holes for talar component. Implant talar component. While protecting the talar surface using retrograde insertion of the trial inlay, insert the tibia component. Insert trial inlay to verify the relative anterior/posterior position of the talar and tibial components. Insert appropriately-sized poly. The poly fits individual patient anatomy. Confirm range of motion with fluoroscopy.

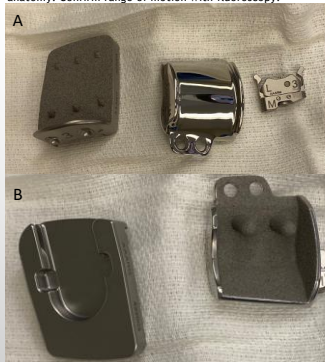


Fig.1: Top-down view (A) and bottom-up view (B) of tibial and talar components of the H2 semi-constrained total ankle system.

### Results

Score	Pre-Op	2-Year Post-Op
AOFAS	33.2	71
VAS	5.9	1.6

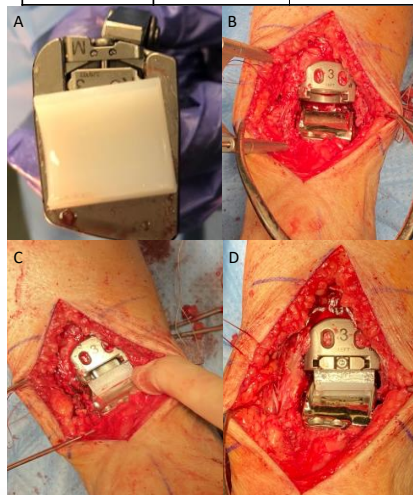


Fig.2: (A) shows the ability of the poly to rotate in the transverse plane and find anatomic fit. Tibial and talar components have been implanted (B). Poly has been inserted into the tibial component and ankle is put through range of motion to find anatomic fit (C). Poly has been locked and implant insertion is complete (D).

### Results

Tibio-talar alignment was significantly improved and maintained through a minimum 2 year follow up ( $p < .005$ ) with no significant change in tibial axis-talar alignment ( $p < .15$ ). There was no evidence of subsidence or transverse plane shift between the 6 week and final follow up radiographs. VAS and AOFAS scores improved from 5.9(2.8) and 33.2(18) preoperatively to 1.6(2.3) and 71 (10.5) post-operatively. A total of 8.3% (n=3) required re-operation. 2.7% (n=1) required revision surgery for poly failure, 5.5% (n=2) underwent incisional debridement post-operatively and healed without complications. Overall survivorship was 97.2% at the average follow up of 2 years.

### Analysis & Discussion

Similar studies have reported survivorship from 92-100% with modern ankle implants at short to mid-term follow up. Although this is a small sample size, our data shows a **97.2% survivorship at 2 years** post-operatively with excellent functional outcome scores noted.

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## Introduction

Eccrine poromas are derived from the intraepidermal portion of eccrine sweat glands.<sup>1</sup> Eccrine poroma is common, benign, slow growing solitary adnexal tumor.<sup>2</sup> Due to the high concentration of eccrine sweat glands in the soles and foot, about two-thirds of the cases occur there.<sup>3</sup> Hands, fingers, neck, chest, forehead, nose, and scalp are other common sites.<sup>2</sup> Eccrine poroma has rarely been reported in the toes.

The exact mechanism of eccrine poromas is unknown. Previously it was suggested that sweat duct cytotoxicity and now remodeling of the sweat gland after chemotherapy was a cause.<sup>3</sup> Others have attributed the predisposition of poroma to genetic defect.<sup>4</sup>

Eccrine poroma usually occurs in middle-aged or elderly people with no sex predilection.<sup>5</sup> The lesions are slow growing, soft to firm, nontender, with skin color to erythematous plaques or nodules. The lesions are well circumscribed with "moat"-like invagination. Typically, sizes ranges from a few millimeters to two centimeters. The lesions can easily be confused for chronic ulcers, melanoma, pyogenic granuloma, basal cell carcinoma, squamous cell carcinoma, or seborrheic keratosis.<sup>5</sup>

Looking at a histopathological photomicrograph, eccrine poroma arises from the lower portion of the epidermis and extends into the dermis as the tumor masses.<sup>6</sup> The cells are smaller than epidermal keratinocytes and have uniform cuboidal appearance and a round deeply basophilic nucleus.<sup>7</sup>

Early recognition and proper treatment of eccrine poroma are of vital importance. Complete excision of the lesion, as well as histopathological assessment, is key to confirm diagnosis and exclude malignant variants. Complete excision of eccrine poroma is curative.

We present a case of eccrine poroma located at the second toe of an 81-year-old patient.

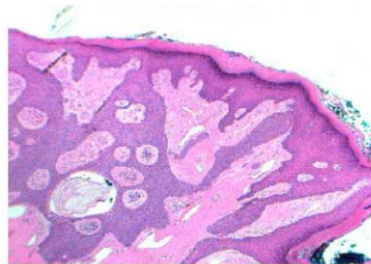
## Case Study

81-year-old patient with a history of CHF, depression, HTN, hyperlipidemia, CKD, previous MI that presented to clinic with a soft tissue mass present at the plantar aspect of the left second digit (Figure 1). The mass was well rounded with no associated signs of infection. There was continued pain present at the area of the mass. Conservative treatment was exhausted. It was recommended for left second digit soft tissue mass excision. The lesion removed was approximately 1 cm x 0.6 cm. Pathology results displayed signs of eccrine poroma and that it was a benign lesion of origin (Figure 2). After two weeks, the sutures were removed, and the incision site was healed. There was no re-occurrence following the removal of the mass.

## Figures



**Figure 1.** Lesion present at the plantar aspect of the second digit



**Figure 2.** Histopathological photomicrograph displaying eccrine poroma.

## Discussion

Eccrine poroma was first reported by Pinkus et al in 1956.<sup>8</sup> In our case, we presented a woman, 81-year-old of age, with a benign eccrine poroma. Although men and women are equally effective, it mainly affects adults over the age of 40.<sup>9</sup> Theoretically, eccrine porocarcinoma progresses from benign eccrine poroma. Eccrine poroma lesions progress to porocarcinoma in no definite time limit. Mean 8.5 years and recent onset of rapid growth in longstanding cases have been witnessed. In our case, early detection was key. Treatment of choice of eccrine poroma is surgical. The tumors must be excised entirely because porocarcinoma can occur in almost half of cases on pre-existing eccrine poroma.<sup>10</sup> Skin biopsy for pathology is indicated in suspected cases of poroma. This may eliminate the diagnosis if its malignant variant. In our case, pathology displayed sections of skin showing abruptly demarcated lobular proliferation of small pale staining squamoid cells with scattered eccrine ducts. The intervening stroma was richly vascularized and fibrotic. The diagnosis was consistent with eccrine poroma. These findings were consistent with eccrine poroma.

## Conclusion

In conclusion, this case report displays a rare soft tissue mass that should be considered as a differential and should be recognized and treated early to prevent future detrimental changes. Complete excision of the lesion may prevent recurrence and change for dysplastic or malignant change.

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# Use of an Intramedullary Nail, PMMA Spacer, and Multiplanar External Fixator in Tibiofibular and Medial Column Arthrodesis in Advanced Stage Charcot Neuroarthropathy: A Case Report

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## Introduction

Charcot neuroarthropathy is a progressive, chronic, and destructive arthropathy most frequently caused by diabetes mellitus. Charcot neuroarthropathy often manifests as subluxation/dislocation and fracture, which imposes a risk of soft tissue ulceration, infection, and in severe cases major amputation.

A plethora of surgical approaches and techniques have been described for the management of Charcot collapse. More traditional methods of fixation are noted to be plates, screws, pins, and staples. Due to the weaker and less organized trabecular bone quality in those with Charcot neuroarthropathy and diabetes, plate and screw fixation methods may not be successful. More stabilizing fixation methods must be investigated given the uniquely poor bone quality of Charcot neuroarthropathy patients.

The purpose of this study is to report the outcomes of ankle and medial column arthrodesis utilizing an intramedullary nail, PMMA spacer, and multiplanar external fixator in a case of advanced Charcot neuroarthropathy.

## Patient and Methods

This is a prospective study of one patient with Charcot neuroarthropathy who underwent a medial column fusion to the tibia, tibiofibular fusion, and cuboid exostectomy as an alternative to amputation. The follow up time after surgery was one year and six months.

Approximately three months prior to the medial column fusion and tibiofibular fusion a polymethylmethacrylate (PMMA) spacer was placed into the patient's ankle joint and a multiplanar external fixator was applied, in a Miter frame fashion. Approximately two weeks prior to the medial column fusion and tibiofibular fusion the multiplanar external fixator was removed.

## Procedures

The patient was placed in the supine position on the operating table. After adequate IV sedation, the lower extremity was prepped and draped in the proper aseptic fashion. A thigh tourniquet was then applied and inflated to 300 mmHg.

A curvilinear incision was made down to bone on the medial aspect of the distal tibia to the proximal aspect of the first metatarsal. A Cobb elevator was used to separate the soft tissue from the PMMA spacer in the ankle joint. The PMMA spacer was placed into the ankle joint during a previous surgery; it was removed and the soft tissue adhesions were released from the distal tibia, superior calcaneus, navicular, medial cuneiform, and first metatarsal base.

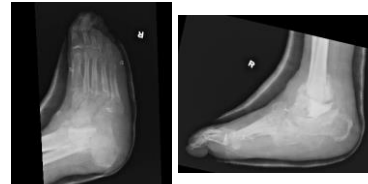
A burr was then used to debride the tibial plafond, the superior aspect of the calcaneus within the subtalar joint, and the posterior aspect of the residual neck of the talus. The body and part of the neck of the talus were removed during a previous surgery. An osteotome was used to create a flat surface between the anterior distal tibia and the residual head of the talus. The head/neck of the talus was manually reduced onto its articulating surface, while the superior aspect of the calcaneus was simultaneously placed in proper alignment with the tibia. The foot was noted to be 90 degrees relative to the leg and it was determined that hardware could now be placed to maintain this alignment. A 6.5 mm cannulated compression headless screw was drilled through the calcaneus into the distal tibia.

An incision was made on the dorsal medial aspect of the first metatarsophalangeal joint (MTPJ) down to bone. The head of the first metatarsal and the base of the proximal phalanx of the hallux were exposed. A k-wire was drilled through the first metatarsal head, medial cuneiform, navicular, and distal anterior face of the tibia. Once adequate placement of the guidewire was confirmed under fluoroscopy, reaming of the intramedullary nail was performed. Once the nail was inserted, the k-wire was removed. Screws were placed in the distal tibia and in the first metatarsal. A synthetic bone graft was packed into the ankle joint, filling the voids present. Finally, the prominent plantar portion of the cuboid was removed.

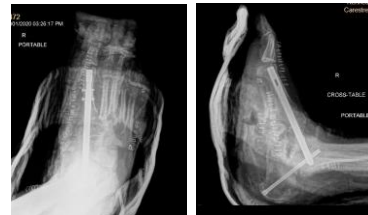
## Results

This is a case report of one patient. The patient achieved vast osseous growth to all surgical sites with remodeling and consolidation to the rearfoot, as seen in the radiographs taken at the last post-operative visit (1.6 years post-op) and validated by clinical exam findings. Positioning of the foot/ankle is maintained from immediate post-op radiographs. There is no passive or active range of motion to the ankle in any plane.

### Pre-op radiographs



### Post-op radiographs



## Conclusions

This case report details a successful outcome of tibiofibular and medial column fusion with utilization of intramedullary nailing and multiplanar external fixation in a patient with severe Charcot neuroarthropathy. This patient has achieved amputation and has had significant improvement in function and quality of life.

At approximately seven months post-op, this patient underwent a partial cuboid excision. At approximately one year and one month post-op, the patient underwent a calcaneal and cuboid osteotomy. Since then, he has had no additional surgeries.

An intramedullary nail facilitates healing in the Charcot foot in many ways. Intramedullary nailing avoids added cortical bone stress and provides stability to the foot by incorporating unaffected segments of bone. Furthermore, a larger contact area between the bone and the fixation offers greater stability for healing of the bony segments.


The prevalence of Charcot foot deformities will continue to increase as the incidence of diabetes increases. Therefore, it is of utmost importance to continue investigating the most advantageous fixation methods for the unique bone quality of patients with Charcot neuroarthropathy.

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