

## INTRODUCTION

The purpose of this study is to describe the ankle disarticulation (AD) and its role in the staged approach to proximal amputation. We offer a case series to help surgeons with patient selection, peri-operative considerations, and inpatient management.

## LITERATURE REVIEW

When attempts to preserve an infected or ischemic limb are futile, below knee amputation (BKA) is undertaken in order to preserve life or patients' quality of life. Oftentimes, a staged approach is required to ensure eradication of infection prior to closure of amputation stump. The most frequently used method of first stage drainage amputation is a transtibial approach, or "guillotine" amputation. The staged approach to below knee amputation has proven to be an effective method to achieving closure of amputation stump (1). McIntyre et al. reported a 97% healing rate of BKA stump following guillotine amputation in diabetic foot infections, while only 78% of those who underwent single stage BKA healed. Additionally, 11% of patients in the single staged BKA group went on to above knee amputation (AKA) compared to 0% in the two-staged group (2). Desai et al. compared a single staged BKA with delayed skin closure 4-5 days later to two-staged BKA with ankle guillotine amputation and found that 33% of patients who underwent the single staged BKA were revised to AKA compared to 7.7% of patients in the two-staged procedure (3). Altindas et al. reported a 95% healing of below knee amputation site following AD with vertical crural incisions (4). Despite its apparent efficacy and proposed benefits, ankle disarticulation for staged amputation continues to be an underutilized procedure, particularly in the Podiatric Surgery community.

## SURGICAL TECHNIQUE

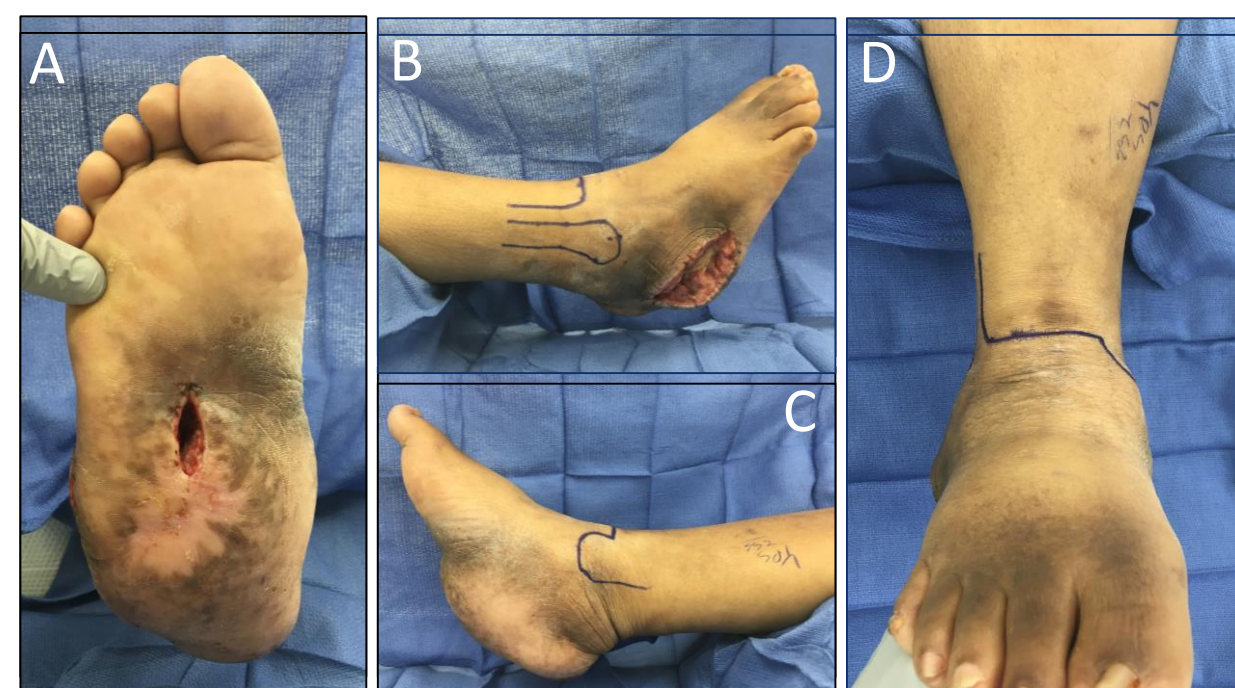


Figure 1: Identification of osseous landmarks. The ankle crease should be the target for incision placement.

## SURGICAL TECHNIQUE

In the supine position, anatomic structures of the ankle joint may be identified with a skin marker (Fig 1). Our standard operative technique involves collecting pre-debridement swab cultures of the infected wound. A thigh tourniquet may be inflated as appropriate. Using a needle-tipped bovie, dissection is carried through the skin at the level of the ankle crease (Fig 1D) and carried through the subcutaneous tissues. Dissection is from anterior to posterior, taking care to clamp major blood vessels to prevent blood loss (Fig 3D). Tension is held on the forefoot in the plantarflexory position to aid with dissection. Upon disarticulation of the tibiotalar joint, vessels are identified and tied. The major compartments of the lower leg are explored for purulence, and vertical crural incisions to decompress the compartments can be performed while taking

procedure (Fig 3E). The tourniquet is released and hemostasis is achieved. The wound is then irrigated with 3L of NS and post-debridement cultures are collected to aid with antibiotic selection and planning for closure. Negative pressure wound therapy (NPWT) with instillation of 0.9% normal saline (NS) may be applied to the wound in the interim. In patients with high risk of blood loss, NPWT should be avoided and twice daily dressing changes with 1% acetic acid may be employed to reduce risk of bioburden formation. A knee immobilizer may be placed at this time if there is high risk of knee flexion contracture. At our institution, final closure is achieved through transtibial BKA by a plastic surgeon (C.E.A.) between 3-7 days following AD with mytenodesis of the tibial and peroneal muscle bellies to the tibia and Ertl bridge technique as indicated.

## CASE SERIES

**Case 1:** A 59 year old female with history of DM1, carotid artery stenosis, DVT, and stroke with right Charcot neuroarthropathy deformity and associated plantar foot wound infection presents from outside hospital following plantar cuboid planing procedure. Found to have plantar soft tissue emphysema and was urgently taken to the OR for incision and drainage. Due to the extent of soft tissue and bone loss, and taking into account the patient's quality of life, the decision was made to undergo staged BKA. The patient was on a daily home regimen of coumadin, lovenox, and Plavix. INR at the time of surgery was 1.0 and H/H was 8.3/28.0. Due to the risk of blood loss and anemia, the decision was made to undergo AD as a staged approach to BKA. Estimated blood loss (EBL) was 30cc. Following hemostasis, NPWT with NS was applied as a sterile dressing. Cultures from the remaining stump revealed no growth. 2 days later, BKA was performed with mytenodesis of the tibial and peroneal muscle bellies to the tibia and closed with minimal tension. The incision was healed and sutures removed at 1 month. The patient is to be fitted for a prosthesis at 3 months post-op.

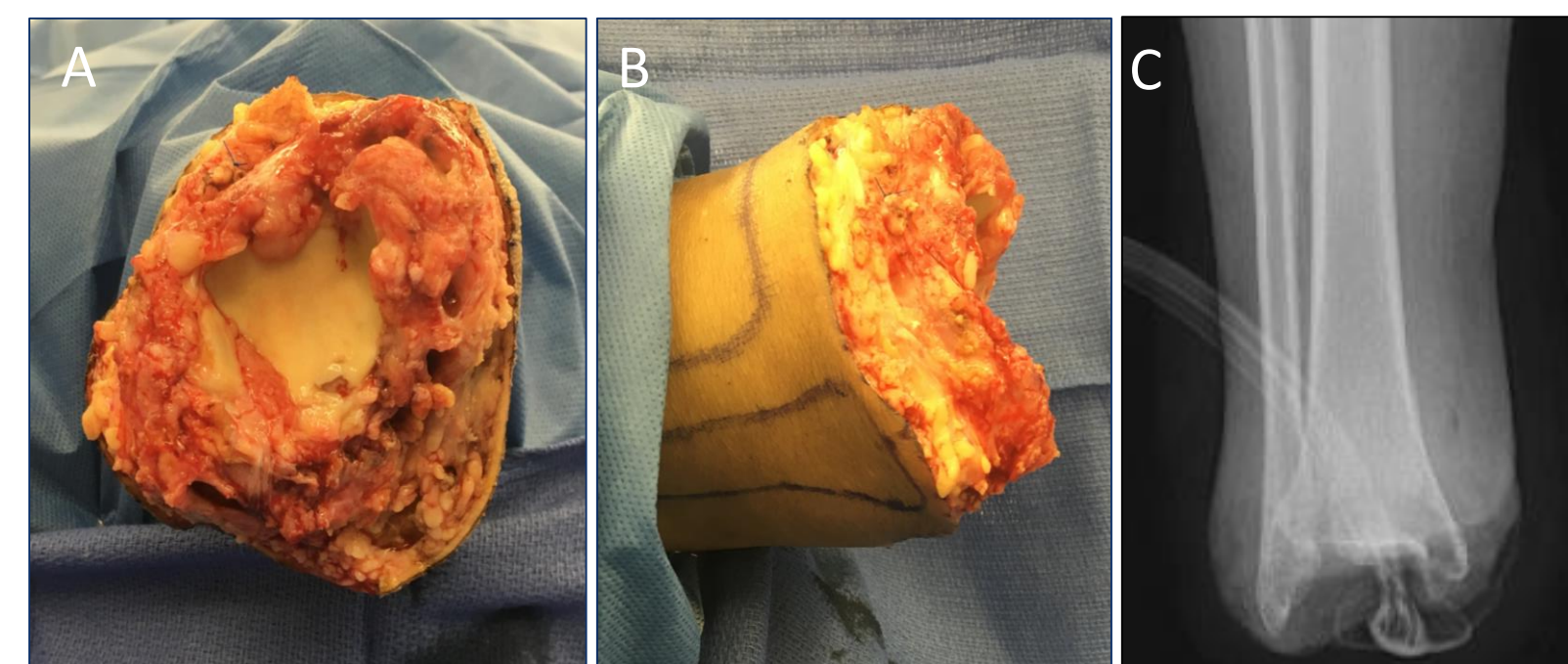


Figure 2: Exposed ankle cross-section prior to release of tourniquet and post-operative radiograph displaying use of NPWT with instillation.

## CASE SERIES (continued)

**Case 2:** A 66 year old male with history of HIV, CAD, MI in 2016, contralateral BKA, who was lost to follow-up and presented to the ER with plantar foot wound infection and WBC 20.1. X-ray showed concern for emphysema in posteromedial ankle. The senior author (J.S.S.) urgently took the patient to the OR for source control. Incision and fasciotomy of the plantar medial compartment of the foot revealed grossly necrotic tissue with concern for ascending infection. The decision was made to undergo ankle disarticulation to properly eradicate the source of infection in this immunocompromised individual. Purulence expressed from medial compartment necessitated a medial vertical crural incision to decompress ascending infection. Liquefactive tissue was thoroughly debrided. The remaining stump was relatively avascular. EBL was 20cc. NPWT was applied to the wound. Due to the patient's significant cardiac history, a thorough vascular work-up was not pursued. The patient underwent BKA 1 week later. Incision was healed and sutures removed 6 weeks later and he is to be fitted for a prosthesis approximately 2.5 months post-operatively.



Figure 3: Concerning wound with emphysema noted just distal to the ankle joint posteriorly on x-ray. Grossly necrotic tissue coursing proximally necessitated ankle disarticulation with medial vertical crural incision.

## DISCUSSION

AD has previously been described as an effective method of staged proximal amputation (3). Our described technique follows our standard protocol for serial operative debridement of wound infection to achieve final closure. The staged approach allows for examination of tissue and bone culture to aid with peri-operative antibiotics while also providing data regarding wound contamination for closure planning. Our case series offers insight into patient selection for this procedure. In anemic patients, this procedure minimizes blood loss that would occur through the exposed medullary canal with the "guillotine" amputation. The procedure itself is simple and requires minimal instrumentation. Both of these factors may provide the benefit of decreased operative time with this procedure. Based on state scope of practice, podiatric surgery can perform AD when called upon. This procedure serves particular importance when incision and drainage reveals proximally tracking infection. It is important to note that proper consent should be obtained from the patient in the pre-operative period. We typically apply NPWT with instillation of 0.9% NS over the open wound as it has been shown to decrease time to final closure when compared with NPWT (5). When applied, the foam directly contacts the cartilaginous stump of the tibia and fibula, and may be packed proximally into concerning compartments. Uncontrolled bleeding, such as from exposed medullary canal, precludes the use of NPWT as it can cause continued blood loss and hematoma formation beneath the dressing. When hemostasis is difficult to achieve, wet-to-dry dressings with 1% acetic acid can be performed to prevent formation of bioburden in the peri-operative period (6). An additional benefit to this procedure is the preserved length of bone as well as tibial and peroneal muscles or tendons to aid with proper BKA planning and can provide options for our plastic surgeon (C.E.A.) to accommodate the functional requirements of the patient and further benefits prosthesis management (7). In this case series and description of technique, we propose that AD with NPWT with instillation may be a beneficial method to staged amputation. The Podiatric Surgeon can play an essential role in the team-approach to patient management by performing this procedure when a patient's limb is deemed unsalvageable.

## REFERENCES

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