



# A reliable surgical approach for the two-staged amputation in unsalvageable limb and life threatening acute progressive diabetic foot infections: Tibiotalar disarticulation with vertical crural incisions and secondary transtibial amputation

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## ARTICLE INFO

### Article history:

Received 30 September 2009

Received in revised form 17 November 2009

Accepted 20 November 2009

### Keywords:

Diabetic foot

Infection

Major amputation

## ABSTRACT

**Background:** If all efforts to treat acute progressive diabetic foot infection remain insufficient, the decision of major amputation should be undertaken. For this purpose, guillotine amputation is usually performed first. However, guillotine amputation below the knee level may cause the corresponding infection to spread to preserved anatomical spaces.

**Method:** First stage of our procedure consists of tibiotalar disarticulation and vertical incisions performed throughout the lower leg to remove the septic foot and drain the compartments. During the interval period, appropriate antibiotherapy and wound care are applied. After the interval period, definitive transtibial amputation is performed in the second stage.

**Results:** Fifty-nine percent of the 62 transtibial amputations were healed completely. Failure developed in 3 cases which required opening of the amputation stump. In one patient, revision amputation at a higher transtibial level was done. Infection and necrosis reached to the knee joint in the other two patients and transfemoral amputation became the only treatment option for these 2 cases.

**Conclusion:** Tibiotalar disarticulation with vertical lower leg incisions as a first stage of two-stage transtibial amputation is a safe and reliable method. It reduces the risk of unnecessary tissue sacrifice and failure rate of the secondary transtibial amputation.

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## 1. Introduction

Diabetic foot infections are often encountered in daily clinical practice. If not treated promptly and appropriately, diabetic foot infections may lead to septic gangrene. If the diagnosis of 'septic foot' is established, the surgeon should be involved in the treatment. Some of the common surgical procedures are incision and drainage of the abscesses, debridement of necrotic materials, removal of any foreign bodies, arterial revascularization and when needed, amputation. Amputation decision is a bothersome and challenging issue for both the surgeon and the patient. However, it is the only option to save the life of the patient in some instances: (1) All efforts to treat acute progressive diabetic foot infection remain insufficient, (2) the treatment does not leave a functional foot for ambulation and (3) the foot continues to be the source of

septicemia. On the other hand, after making a decision of major amputation, we face other challenging issues that need to be addressed. It is crucial to determine the amputation level and to decide whether primary definitive or two-staged amputation should be done. Since the transfemoral amputation usually ends up with high morbidity, it is wise to keep the amputation level below the knee in these patients.

Primary definitive amputation performed in the presence of acute progressive foot infection carries a high risk of wound infection [1]. Therefore, several authors have advocated the two-staged amputation technique which allows secondary wound closure with a reduced chance of wound infection [2]. For this purpose guillotine amputation is usually performed at the first stage. Although the guillotine amputation is quick and safe method, it has some significant disadvantages. Classical guillotine amputation performed below the knee level may cause the infection and necrosis to spread to preserved anatomical spaces between muscles and bones. In addition, after being cut, during the interval period the retraction of muscles occurs which leads to difficulty in obtaining reliable coverage of the stump. These efforts

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might end up with short stump and flexion contracture of the knee. Eventually, these patients are unable to wear prosthesis. After recognizing these drawbacks in our practice, we decided to develop our way to solve these issues.

This study reports a two-staged approach consisting of tibiotalar amputation with the vertical crural incisions as a first stage and a transtibial amputation as a definitive second stage in a series of diabetic patients with unsalvageable limb and life threatening acute progressive diabetic foot infections.

## 2. Material

Between 2000 and 2008, 62 patients with unsalvageable foot due to acute progressive diabetic foot infection have undergone two-staged transtibial amputation. There were 38 male and 24 female patients. Mean age was 65.8 years, ranging between 46 and 87. All patients had Type 2 diabetes. Neuropathy was present in 96% ( $n = 59$ ) of the patients. 6 patients were on hemodialysis treatment. Both peripheral pedal pulses (A. Tibialis posterior and A. Dorsalis pedis) were palpable in 16% ( $n = 10$ ) of patients. Thirty percent ( $n = 19$ ) of patients had at least one palpable peripheral pedal pulse. Remaining 54% ( $n = 33$ ) of patients lacked palpable pedal pulses. Twenty-six of the patients without pedal pulses had palpable popliteal pulse, whereas the remaining seven patients did not. All patients were examined by a vascular surgeon but did not meet the criteria for vascular surgery bypass.

## 3. Technique

### 3.1. First stage: tibiotalar disarticulation and vertical incisions

All procedures were performed under regional or peripheral nerve block anesthesia. After preparation of the extremity with antiseptic solution, the involved extremity is laid on the trapezoid pillow [3]. We did not use tourniquet in any of the operations. The foot is positioned to slight plantar flexion in order to ease the access to tibiotalar joint. Then, the circumferential skin incision is done over the tibiotalar joint at the level of the both malleoli. All anatomic structures are cut from anterior to posterior until amputation is completed.

Infections at distal levels of the extremities usually follow the two main routes while spreading to more proximal levels; great and lesser saphenous veins. Therefore the anatomic pathways of these structures should always be checked with a probe or the forefinger without exerting much pressure. If subcutaneous tissue is easily separated from the underlying tissue by this maneuver, a vertical crural skin incision should be made throughout the dissected plan. To avoid unnecessary tissue sacrifice, this step should be done cautiously by minimizing the incision length. However, the incision should be long enough to allow sufficient drainage.

### 3.2. Interval period (wound management)

The open wound is managed with wet-absorbing dressings with the 0.09% NaCl solutions twice daily. Bed rest with elevation of affected extremity and antibiotic therapy are also essential components of the treatment. During this period, wound should be observed for the signs of necrosis and infection. Serial debridements are performed during this period when necessary.

### 3.3. Second stage: transtibial amputation for definitive closure

At this stage, transtibial amputation is performed by transecting the tibia and fibula at the same level as appropriate stump length (12–14 cm generally) and reliable coverage of the distal

stump would be obtained. To decrease the sharpness of the bony stump, a part of the bone is excised from the anterior edge of the bony stump in conical shape. In addition, to increase the durability of the amputation stump, the anterior tibial muscle is wrapped around bony stump. By leaving a long posterior skin flap, it is usually possible to cover the anterior soft tissue defect that may extend to 1/3 of proximal part of the leg. If the primary closure cannot be achieved with posterior flap, a small split-thickness skin graft can be applied over the muscle to close the anterior superior tibial defect. The grafted area does not interfere with the prosthesis use because of its distant location from the weight-bearing area. A long leg cast is used to prevent early contracture of the knee after the amputation.

## 4. Case reports

### 4.1. Case 1

A 63-year-old female with 20-year history of diabetes was admitted to our hospital after an unsuccessful amputation of 5th toe and subsequent progressive, severe infection of the left foot (Fig. 1A and B). At 6th day of hospitalization, we have performed tibiotalar disarticulation and adequate vertical incisions (Fig. 1C). After 19 days of disarticulation, a successful transtibial amputation was performed (Fig. 1D).

### 4.2. Case 2

A 74-year-old male patient with 21-year history of diabetes was admitted to our hospital with a forefoot lesion and progressive infection of the right foot and the lower leg (Fig. 2A). After a preparation period (about 48 h), tibiotalar disarticulation and appropriate vertical incisions were performed for drainage (Fig. 2B). With two-staged amputation, adequate muscle bulk was present to cover the bony stump (Fig. 2C). Transtibial amputation was performed successfully (Fig. 2D).

### 4.3. Case 3

A 53-year-old male patient with 16-year history of diabetes was admitted to our hospital from a different clinic due septic shock. A generalized, acute, progressive infection with gas formation and necrosis was present in both lower extremities (Fig. 3A). After a systemic local wound preparation, left tibiotalar disarticulation and right soft tissue debridement were performed (Fig. 3B). After left transtibial amputation and right lower leg skin grafting we have achieved complete healing (Fig. 3C and D).

### 4.4. Case 4

A 62-year-old female with 15-year history of diabetes and 4-year history of dialysis admitted to our hospital due to acute progressive septic infection and necrosis of right foot. Even with minor amputations, incisions and debridements we could not control the infection (Fig. 4A and B). We have performed a successful two-staged transtibial amputation (Fig. 4C and D).

## 5. Results

Tibiotalar amputation was performed in 30 patients within 48 hours of hospitalization. Remaining 32 patients underwent the first stage operation within first week. Interval period between the first stage and second definitive closure ranged from 12 to 42 days. Mean value was 19 days for all 62 patients.

At the end of the interval period, the lower leg incisions of 20 patients were limited up to middle 1/3 of the tibia. All of these



**Fig. 1.** 63-year-old female, 20-year history of diabetes, admitted to our hospital after an unsuccessful amputation of 5th toe and subsequent progressive, severe infection of the right foot (A and B). At 6th day of hospitalization, we have performed tibiotalar disarticulation and adequate vertical incisions (C). Postoperative 55 days after a successful secondary transtibial amputation (D).



**Fig. 2.** A 74-year-old male, 21-year history of diabetes, admitted to our hospital with a forefoot lesion and progressive infection spreading to dorsum and ankle region of the right foot and the cruris (A). After a short preparation period (about 48 h), tibiotalar disarticulation and appropriate vertical incisions along the pathway of infection were performed for drainage (B). With two-stage amputation, adequate muscle bulk were present to cover the bony stump (C). Postoperative 2nd month after transtibial amputation (D).



**Fig. 3.** A 53-year-old male, 16-year history of diabetes, hospitalized in ICU (intensive care unit) for generalized acute infection and septic shock (A). Tibiotalar disarticulation was performed (B). After energetic local wound care, transtibial amputation and skin grafting, complete healing was achieved on both extremities (C and D).

patients had sufficient length of muscle and skin for the primary closure of transtibial amputation stump. Therefore, transtibial amputation with primary closure was achieved without any difficulties. On the other hand, ten patients had the anterior soft tissue defect extending into the upper 1/3 of the cruris. We achieved the primary closure by preparing the long posterior skin flaps in most of these patients. Reconstruction of the pretibial skin defect with a skin graft was required for 4 patients who had large anterior lower leg skin defect.

A healed amputation stump was considered a successful result. Any ulceration or the surgical revision required for necrosis and infection was defined as failure. Fifty-nine (95%) of the 62 transtibial amputations healed primarily. Of these 59 cases with successful results, five cases healed with minor soft tissue infection. In 3 cases, severe infection and necrosis developed at the amputation stump which required debridement of the amputation stump. In all of these cases, open wound management with appropriate wet dressing method was used to eliminate



**Fig. 4.** A 62-year-old female, 15-year history of diabetes and 4-year history of dialysis, admitted to our hospital due to acute progressive septic infection and necrosis of right foot. Even with minor amputations, incisions and debridements we could not control the infection (A and B). We have performed a successful two-staged transtibial amputation (C and D).

infection and necrosis. In one patient, revision amputation at a higher transtibial level provided primary healing. Infection and necrosis reached to the knee joint in other two patients despite all efforts. Unfortunately, we were not able to treat septic arthritis, therefore transfemoral amputation became the only treatment option for these two patients. At the end of treatment period all patients were able to wear their prosthesis.

## 6. Discussion

The forefoot is usually considered to be the starting point of the most acute progressive diabetic foot infections [4]. These infections are more likely to extend to the mid and hindfoot levels and eventually may give serious damage to subcutaneous tissues, tendons, fascias, adipose tissue, muscles and skin. At last, it may reach to the lower leg throughout the lymphatics.

Although this progression usually ends up with the septic unsalvageable foot, during the early phase of the infection the bones and joints of the mid and hind foot are still free of infection. Therefore, appropriate incisions for drainage at the early stages are the most effective treatment method to prevent the major amputations [5]. Many authors agree with the concept that urgent major amputation is an appropriate course of action for the treatment of septic diabetic foot characterized by extensive necrotic infection, bone and joint involvement [6,7]. After the amputation decision, the surgeon faces other challenging issues. First decision is the level of amputation. Higher-level amputations are associated with the increased metabolic cost of walking and the decreased self-selected walking speed [8]. The diabetic patients who usually have concomitant multiple systemic diseases and limited cardiopulmonary reserve are adversely affected by these factors. To optimize the potential of these patients to walk after amputation, it is more reasonable to perform below-knee amputations. Another concern is about the management of the amputation stump. Primary definitive amputation performed in the presence of acute progressive foot infection carries a high risk of wound infection [1]. Therefore, we advise two-staged amputation method. The classical transtibial guillotine amputation has been usually performed in the first stage. Although it is quick and reliable, during our practice, we have noticed that it has significant disadvantages. It is not uncommon that the infection and necrosis spread to the preserved anatomical structures after this operation. In addition, after being cut, the physiologic retraction of muscles occurs which turns to permanent muscle retraction during the interval period. Providing reliable coverage of the stump with these tough muscles is sometimes very difficult and may lead to shorter amputation stump.

We recommend tibiotalar disarticulation to be done in the first stage as soon as possible. Although we were able to perform the first stage in about half of our patients within 48 h, we delayed the first stage in the remaining patients.

Tibiotalar disarticulation can be done almost within seconds. It allows fast removal of the septic foot and does not bring an extra burden to the patient. General signs of septic infection subside rapidly and dramatically within hours after the septic foot removal. Additionally, articular surface, joint capsule and periarticular fibroreticular tissues act as natural strong barriers to the bacterial invasion preventing spread of infection to the cruris.

Acute progressive foot infection may spread by following the lymphatic vessels which accompany the great and lesser saphenous veins. It leads to dilatation of the lymphatic vessels and reduces the lymphatic flow as well. If it is not treated effectively, the ascending soft tissue infection becomes more severe and causes extensive damage to subcutaneous tissues and fascia. This

process results in more necrosis. Then, the infection and necrosis pass to the posterior part of the cruris and affect the Achilles tendon. There is a great possibility that the chain of these events have already started before the first stage of operation. Therefore, the tibiotalar disarticulation may not be enough to get the infection under control before spreading to the cruris. If there are acute infection signs in the cruris, the drainage incisions should be done in the first stage of treatment. If there is suspicion of infection, the course of great and less saphenous veins should be checked. A finger or a stile can be used for this purpose without exerting too much pressure. If subcutaneous tissue is easily separated from the underlying tissue with this maneuver, vertical skin incision should be made throughout the dissected plan. In this way, it is possible to reach the infected areas to perform more effective dressing. We strongly recommend this approach even if there is a small doubt about the infection.

Vertical skin incisions have additional benefits also. These incisions can be elongated to the more proximal levels. Thus, dilated lymphatics filled with bacteria can be managed with the wet-absorbing dressing. Our two-stage amputation procedure has an intermediate period between the first and second definitive closure stage. This period is actually present in all two-staged procedures. We believe that this period is crucial and requires convenient actions for success in the secondary definitive closure. Debridement and dressing are the essential steps during this period. We have used wet-absorbing dressing with the 0.09% NaCl solutions twice daily for open wound management for about 30 years.

The aim of debridements and dressing is to make the wound free of infection, and to form uninterrupted, clean and fresh healthy granulation tissue. Soft tissue debridement was enough to achieve these goals in most of our cases. The infection and necrosis of the fibroreticular tissue around the prepatellar area was present in two of our patients. Transfemoral amputation had to be performed in two patients who developed septic arthritis of the knee.

## 7. Conclusion

Tibiotalar disarticulation is a quick and reliable method to remove the septic foot. Unlike the classical transtibial guillotine amputation, it prevents the spread of the infection to the intact preserved deep anatomical structures such as muscles and bones. Additionally, the permanent muscle retraction is not seen and reliable coverage of the amputation stump is easily achieved. Since the unnecessary tissue sacrifice is diminished, open tibiotalar disarticulation meets the requirements of reconstructive amputation. We emphasize that the elimination of the ascending soft tissue infection with appropriate vertical crural incisions is the essential step to reduce the failure rate in the secondary transtibial amputation.

Tibiotalar disarticulation with vertical crural incisions as a first stage of two-staged transtibial amputation is a safe and reliable method. It reduces the risk of unnecessary tissue sacrifice and failure rate of the transtibial amputation. Since this method conforms to the reconstructive amputation principles, it is more likely to achieve the functional amputation stump allowing proper prosthesis use.

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