

The Limb Salvage Approach for the Surgical Management of Necrotizing Soft Tissue Infection

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Summary: Necrotizing soft tissue infection (NSTI) is a complex infection known for its rapid progression of necrosis within the subcutaneous tissue and fascia. Time is of essence for the management of NSTI. In this report, we present a case of NSTI after infection of poorly managed diabetic foot ulcer in the ankle. The limb salvage approach involves sequential staged procedures. Multiple surgical debridements and “washout” were performed for source control. At the same time, the patient also received a systemic antibiotic regimen. In the second stage, a perforator free flap taken from the anterolateral thigh was used to repair the extensive soft tissue defect and reconstruct a functional foot to achieve maximal limb salvage. The kickstand technique of external fixation was used to reduce soft tissue compression and enhance the surgical offloading of the skin flap. At the 2-year follow-up, the skin integrity of the flap was well-preserved, and the patient returned to his premorbid quality of life. (*Plast Reconstr Surg Glob Open* 2023; 11:e5207; doi: [10.1097/GOX.0000000000005207](https://doi.org/10.1097/GOX.0000000000005207); Published online 15 August 2023.)

Previously known as necrotizing fasciitis, necrotizing soft tissue infection (NSTI) is a rare and severe infection characterized by the rapid development of necrosis within the subcutaneous tissue and fascia. It is predominately caused by group A *streptococcus*, but also includes common aerobic and anaerobic pathogens such as *S. aureus*, *E. coli*, *P. aeruginosa*, *Bacteroides*, *Clostridium* species, as well as multidrug-resistant organism such as methicillin-resistant *S. aureus* (MRSA).¹ The rapid and complex nature of NSTI necessitates immediate attention and a swift work-up plan to contain the spread of infection.

In this case report, we present a case of NSTI secondary to diabetic foot infection. Early aggressive intervention comprises serial surgical debridements, antibiotic regimen, and wound closure by anterolateral thigh (ALT) perforator free flap. In addition, the kickstand technique for external fixation was used to achieve greater stabilization of the ALT perforator free flap.

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CASE

A 42-year-old Chinese man presented with infected diabetic foot ulceration with dermal necrosis over lateral malleolus of his right foot. Soft tissue swelling and erythema with increased skin temperature extending from dorsolateral midfoot to the anterolateral lower limb were observed. [See figure, Supplemental Digital Content 1, which displays the staged procedure for clinical management of NSTI. Initial examination found a 3cm by 3cm ulceration over the lateral malleoli with surrounding dermal necrosis. Swelling, erythema, and warmth from dorsal midfoot extend toward the lateral lower limb (1A). Early aggressive surgical debridement and “washout” was performed on the day of admission, and two more subsequent surgical debridements over the next 8 days, leaving behind massive soft tissue defect (1B). In the second stage, a perforator free flap was taken from the anterolateral thigh and transplanted onto the dorsolateral foot (1C&D). The kickstand technique for the circular external fixation was used to prevent soft tissue compression over harvest site and enhance flap uptake. Full wound closure was achieved within 8 weeks. Patient underwent intensive rehabilitation, and he was able to return to premorbid status with normal ankle dorsiflexion range of motion (1E). <http://links.lww.com/PRSGO/C738>.]

Apart from diabetes mellitus, the patient had no significant medical history. The patient was febrile (39°C).

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and hypotensive at the time of admission. Laboratory investigation showed leukocytosis ($18 \times 10^5/\mu\text{L}$), elevated levels of c-reactive protein (CRP) (16 mg/dL), hemoglobin (12.2/dL), and glucose (190 mg/dL). Ultrasonography shows extensive fluid accumulation in the lateral calf and diffuse soft tissue swelling in the deep fascia layer. There was no remarkable arterial occlusion in bilateral lower limbs. Emergency exploration and debridement was performed on the day of admission, and two subsequent surgical debridements were done over the next 8 days. As a result, a large tissue defect measuring approximately 15 cm by 20 cm and stretching from the dorsolateral foot to the distal calf was created, and multiple tendons, including anterior tibial, posterior tibial, and long extensor tendons, were resected (Supplemental Digital Content 1B, <http://links.lww.com/PRSGO/C738>). Negative pressure wound therapy was applied using -125 mm Hg continuous pressure. Meanwhile, he was treated with IV piperacillin-sulbactam 4.5 g BD for 14 days after microscopy culture and sensitivity testing. In the second stage, a perforator free flap measuring 13 cm by 24 cm was designed and taken from the ALT for soft tissue repair and reconstruction of functional limb (Supplemental Digital Content 1C, <http://links.lww.com/PRSGO/C738>). The perforator flap was elevated with the vascular pedicle comprised of two perforator vessels, and the descending branch of the lateral circumflex femoral artery was identified and resected (Supplemental Digital Content 1D, <http://links.lww.com/PRSGO/C738>). The main trunk of the lateral femoral circumflex artery was used for anastomosis in end-to-end fashion to the great saphenous vein and the anterior tibial artery. The ALT perforator free flap was carefully placed on the recipient site and sutured. A cross-ankle external fixator was used to maintain the dorsiflexion of the ankle joint for 8 weeks. After the removal of external fixation, the patient underwent intensive rehabilitation (Supplemental Digital Content 1E, <http://links.lww.com/PRSGO/C738>). At the 2-year follow-up visit, normal ankle dorsiflexion was achieved.

DISCUSSION

NSTI typically occurs after penetrating injury, from which the infection spreads rapidly and causes extensive inflammation, edema, and hyperemia.² Among several risk factors, age and diabetes mellitus are commonly associated with higher incidence of lower limb amputation and poor prognosis.³ Delay in appropriate management leads to mortality and amputation rates of 32% and 70%, respectively.⁴⁻⁶ Early surgical intervention within 6 hours leads to 40% reduction in fatality.³

Early clinical symptoms of NSTI mimic cellulitis or other superficial skin infections, and they are difficult to discern between. Misdiagnosis can be as high as 70%, whereas accurate diagnosis occurs only 15% of the time during the course of admission.^{7,8} As they progress, patients may develop blisters, malodorous discharge, soft tissue emphysema, crepitus, clinical symptoms of hypotension, and tachycardia.^{1,2} Furthermore,

the reliability and predictive value of Laboratory Risk Indicator for Necrotizing Fasciitis (LRINEC) score from laboratory investigation varies and is uncertain.¹⁻³ Among the various imaging modalities, computed tomography and magnetic resonance imaging have been recommended, as their superiority to delineate soft tissue abnormality and the visualization of the accumulation of air pockets, but both lack the specificity to distinguish from soft tissue swelling of noninfective origin.¹⁻³ In our case, the patient presented typical clinical symptoms of soft tissue infection and LRINEC score was 8, high risk for NSTI. Immediate exploration and debridement was performed without delay and the need for advanced diagnostic imaging.

The gold standard of care for NSTI has been early aggressive debridement of necrotic tissue. In our case, the patient underwent washout and surgical debridement on the day of admission and subsequent aggressive debridements within the next 24–72 hours. These debridements aim to achieve the objective of source control, limb salvage, and preservation of limb function. Amputation can be considered in the case of severe infection, or limb salvage cannot be achieved beyond reasonable doubts. After the resolution of systemic inflammatory symptoms, the focus shift toward repair and reconstruction of extensive soft tissue defect. Skin grafting is insufficient to repair the soft tissue defect created by the aggressive debridement. Hence, we proceed with the option of skin flap taken from the patient's anterolateral thigh for wound closure. We design a perforator ALT free flap with fascia lata for the repair of tendinous structure within the extensor muscular group in the distal lower limb and the foot. This could help address the potential of foot drop, especially after the resection of ATA and extensor tendons.

In an effort to reduce soft tissue compression of skin graft, we used the kickstand method for surgical offloading and enhanced stabilization of the circular extensor fixator.⁹ The external fixation is applied over 8 weeks while keeping the lower limb in non-weight bearing status. After the removal of external fixations, the patient received intensive rehabilitation by a physical therapist. At the annual follow-up, the patient exhibited good recovery to normal quality of life.

CONCLUSIONS

The immediate management of NF requires thorough clinical assessment and early aggressive surgical debridements to accomplish effective source control. It is only when clinical symptoms have subsided that we can direct the attention to repair and reconstructive work using free flaps. The addition of the surgical offloading concept proved to be beneficial, to allow faster uptake of skin flaps and optimize wound closure.

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DISCLOSURE

The authors have no financial interests to declare in relation to the content of this article.

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