A Skin-Sparing Approach to the Treatment of Necrotizing Soft-Tissue Infections: Thinking Reconstruction at Initial Debridement

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The rapid progression of a necrotizing soft-tissue infection (NSTI) makes prompt and aggressive surgical intervention crucial to survival. During the past decade, increased awareness, earlier diagnosis, advances in critical care, and appropriate surgical interventions have all contributed to the overall decrease in mortality of NSTI, from 10% to 12%[1-5] to 4.9%.[6] Increasing survivorship demands that the focus expand from purely preserving life to preserving quality of life.

Surgical techniques recommend wide debridement of all associated skin, subcutaneous, and soft tissue. Such defects can leave survivors with large surface-area wounds comparable with a full-thickness burn. Skin grafting and extensive rehabilitation are necessary to mitigate disfigurement, limited joint mobility, and chronic pain. When debridement focuses only on tissue directly involved in necrosis, viable skin and subcutaneous tissue can remain in place despite wide debridement of deeper tissue planes. We introduce this technique as a skin-sparing debridement.

We designed incision diagrams for each body region to allow full access to underlying diseased tissue and were mindful of future reconstruction through the following basic principles: maintain unaffected skin, preserve skin perforator blood vessels, and cover joints and vital structures. In this article, we describe the rationale and implementation of this technique, as well as a case series of skin-sparing debridements and subsequent reconstruction for patients with NSTIs at our institution. This approach has decreased skin graft size and allowed some wounds to be closed by delayed primary closure (DPC) alone.

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HISTORIC RATIONALE

Improved patient survival often drives the adaptation of surgical techniques. The evolution of the surgical management of breast cancer illustrates this concept well. Mortality was the primary consideration in 1894, when Dr William Halsted first described the radical mastectomy.[7] Despite producing substantial morbidity and disfigurement, this method remained the standard of care for more than 50 years, until Drs Patay and Dyson described the modified radical mastectomy.[8] This was followed by the introduction of the skin-sparing mastectomy by Drs Toth and Lappert in 1984.[9] As focus shifted toward quality of life, skin-sparing and nipple-sparing mastectomies have demonstrated improved aesthetic and quality of life outcomes without compromising oncologic outcomes.[7,9,10]

Although survival remains a primary goal for patients with NSTI, we propose that the evolution of its surgical treatment also follow a skin-sparing strategy. Traditional surgical technique describes wide debridement of all necrotic tissue for source control, as this is most closely associated with favorable outcomes.[3-5] With extensive skin and soft-tissue losses, often the only reconstructive option is skin grafting—similar to burn reconstruction. Skin grafting is a reliable reconstructive approach, however, skin grafts have well-described drawbacks, including poor contour and color mismatch, uneven meshed appearance, decreased elasticity, pruritus, hypersensitivity to pain and sunlight, and the propensity for joint contractures along flexor surfaces and erosive changes over extensor prominences.

To address these shortcomings, we sought a safe method for NSTI debridements that would maintain maximal native tissue to improve reconstructive options for these patients. The aim was to minimize the surface-area healing by secondary intention or requiring skin grafting.

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SKIN-SPARING INCISION DESIGNS

Background

The incision designs use the concept of vascular arcades, perforator blood supply, and delay phenomenon. Similar to the vascular arcades of the intestines from the mesenteric vessels, the skin and subcutaneous tissue have vascular arcades from main source vessels throughout the body.[11] The skin and subcutaneous tissue vascular arcades are from smaller blood vessels called perforators. Vascular arcades join adjacent blood supplies through arterial choke vessels and avalvular veins, which control the pressure gradient across capillary beds and oxygen delivery.[11,12] When an arcade is ligated—as with an incision or undermining a flap—the adjoining choke vessels dilate to accommodate additional blood flow based on tissue oxygen demand. In response, these choke vessels dilate and hypertrophy during the next 48 to 72 hours.[13-15] This permanent vessel enlargement is termed the *delay phenomenon*.[13-15] It allows for viability of an increased tissue area beyond what would normally be perfused by a single perforator arcade.

The concept of perforators and the delay phenomenon is of critical importance to the success of skin-sparing debridement for NSTIs. The spared skin's underlying vascular supply might be completely compromised secondary to myofascial necrosis or subsequent debridement with large undermining. In this setting, the adjacent intact perforators and vascular arcades provide the blood supply to overlying spared skin through increase blood flow via the delay phenomenon.

Incisions designs

As a combined effort between the Department of Surgery and Division of Plastic Surgery, we designed incision diagrams for each body region for initial rapid and complete debridement and were mindful of future reconstruction (Figs. 1 to 4). These approaches allow for full and unrestricted access to underlying diseased tissue by following a set of standard basic principles: maintaining uninvolved skin, preserving skin perforator blood vessels, and covering joints and vital structures. Key points are outlined in Table 1.

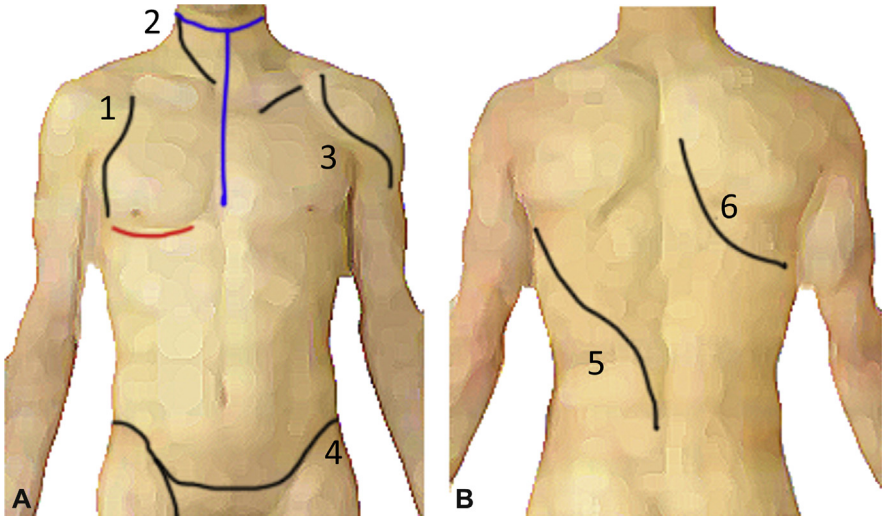

Figure 1. Skin-sparing incision diagrams: torso. (A) Anterior. (1) The lateral chest incision runs along the deltopectoral groove. If needed, an inframammary incision can be used to access tissue deep to the breast (red line). (2) The neck is approached via a Z or lazy S, similar to that used for a neck dissection. If the infection does not have laterality or there is concern for concurrent mediastinitis, a "hangman" approach can be used (blue line). (3) A supraclavicular or infraclavicular incision can be useful for a counter incision for a lower chest infection. The shoulder should be approached through the soft tissue around the deltoid, with attempts to preserve soft tissue over the acromion. (4) An abdominoplasty incision allows for extensive exposure to abdominal well. This can be extended inferiorly into the groin for additional debridement, especially in infections within a large pannus or Fournier gangrene. The incisions should be mindful of the anterior iliac spine as well as the femoral vessels. (B) Posterior. (5) A lazy-S incision is used to access the underlying latissimus dorsi muscle and provides extensive exposure to the lower back. (6) A curvilinear incision allows for access to the upper back, and preserved coverage over the scapula. (From: Waschke J, Böckers TM, Paulsen F. Anatomie Das Lehrbuch. 1st ed. Munich, Germany: Elsevier GmbH, Urban & Fischer; 2015, reprinted with permission.)

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