Surgical Excision of Burn Wounds

Best Practices Using Evidence-Based Medicine

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KEYWORDS

• Burns • Excision • Immune function • Wound healing • Scar minimization

KEY POINTS

- The ability to evaluate burn depth is critical to planning surgical excision.
- Assessment of tissue viability is key to proper burn excision and can be achieved by evaluating for punctate bleeding, patent vessels, pearly white appearance of the dermis, absence of ecchymosis, and bright yellow fat.
- Early excision has improved outcomes by decreasing overall mortality, incidence of wound sepsis, and length of hospital stay.

INTRODUCTION

The management of burns is a multidisciplinary cooperation of all specialties from surgeons and nurses to therapists and nutritionists, and all who have patient contact. Unfortunately, burn wounds can lead to scarring, wound sepsis, and even death, mandating early, safe, and efficient treatment. The decisions to remove the burn tissue are critical to survival in many patients. The most important decision making in burns then, is deciding when to perform surgery and at what depth to debride for the most optimum healing and patient recovery.

EVALUATION AND DEPTH OF BURN WOUNDS

The surgical management of burn injury is influenced by the depth of injury. Superficial (first-degree) burns involve only epidermis and are treated entirely nonsurgically. Partial-thickness (second-degree) burns penetrate into the dermis with a variable depth. Superficial partial-thickness burns penetrate to the papillary dermis, whereas deep partial-thickness burns penetrate deeper into the reticular dermis. Partial-thickness burns have the ability to re-epithelialize naturally from stem cells surrounding the dermal appendages (hair follicles, sebaceous glands, sweat glands, and apocrine glands). Often times, superficial partial-thickness injury can be treated without excision and grafting, with expected healing within 10 to 14 days. Deep partial-thickness burns, however, often take longer to heal, with an increased incidence of hypertrophic scarring. Finally, full-thickness burns cause a level of injury down to subcutaneous fat, eradicating the dermal appendages and eliminating a source for cutaneous regeneration, therefore requiring surgical debridement and grafting.

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When evaluating depth of burn injury, one must take into consideration the thickness of the skin layers in the area of injury, which can offer varying degrees of protection from thermal exposure. The epidermal thickness can vary from less than 1 mm in the genitalia and eyelids to greater than 10 mm on the back. The dermis also varies in thickness depending on the age of the patient, with thinner dermis present in children and elderly patients. Therefore, surgical management may vary based on the patient's age and the location of the burn.

Burn wounds have been described as 3 concentric zones with varying tissue injury including a central zone of coagulation, a surrounding zone of stasis, and an outer zone of hyperemia.[1] The zone of stasis is an ischemic, yet initially viable portion of skin that surrounds the nonviable zone of coagulation. This zone is particularly susceptible to insults that can induce conversion to nonviable tissue including improper resuscitation or delayed excision of burn eschar, causing inflammation or bacterial infection.[2–4]

HISTORY OF SURGICAL MANAGEMENT OF BURN WOUNDS

Prior to the mid 1900s, the management of burn injuries was primarily medical, where wounds were treated with topical medications only. When full-thickness burns were treated nonsurgically, the natural progression was separation of the eschar from the underlying wound bed weeks to months after the initial insult. This left a granulating wound that was still in need of grafting or was allowed to scar in, leading to prolonged hospital stay, hypertrophic scarring, contractures, wound sepsis, multisystem organ failure, and at times death.[5]

The paradigm shift toward early burn excision occurred in 1970 when Janzekovic showed improved patient outcomes with tangential excision and complete removal of necrotic tissue with autografting on the preserved well-vascularized deep tissue.[6] This ground-breaking study showed a reduction in pain, total number of procedures for wound closure, and length of hospital stay. The study was followed by multiple others in support of early excision due to additional benefits including quicker healing, less incidence of hypertrophic scarring, decreased incidence of wound sepsis and need for antibiotics, and a greater than 3-fold decrease in mortality rate.[7–11] Early excision had already become the standard of care when the relationship between burn eschar, inflammation, and systemic inflammatory response syndrome was discovered. Systemic instability was shown to be induced by inflammatory mediators from burn eschar, and this response can be attenuated with early excision.[2,12] As the burn size approaches 15% to 20% total body surface area (TBSA), the inflammatory mediators are prevalent enough to cause a systemic inflammatory response, therefore justifying the need for massive fluid resuscitation to prevent conversion of burn and early excision to abort the inflammatory cascade.

Recent work on animal models has given further insight into the benefits of early burn wound excision. Although animals exhibit a much quicker capacity to heal burn wounds, they have contributed to the basic understanding of certain phases of the healing process in respect to people. Singer and colleagues[13] have shown that tangential excision and grafting of full-thickness burns in a porcine model can decrease timing to heal as well as produce significantly thinner scars when performed early at day 2 versus later at day 14. Additional porcine studies have shown delayed excision and grafting to correlate with significantly worse Vancouver scar scale scores and increased fibrosis and alpha-smooth muscle, suggesting that delays in excision can increase incidence of hypertrophic scarring.[14] Wang and colleagues[15] used a rabbit model to show that tissue edema, wound contracture, and graft loss was significantly greatest when excision and grafting occurred at 18 to 24 hours, suggesting that it may be beneficial to perform excision and grafting either ultra-early or after 48 hours.

Burn injury has been shown to have suppressive effects on both the innate and adaptive immune response, leaving patients at risk for viral and bacterial infections. The effect of timing of excision on the immune system has therefore also been the target of animal models. Early complete excision of burn wounds in mice has been shown to restore cytotoxic lymphocyte function and viral-specific T lymphocyte cytotoxicity for the innate immune system.[16,17] Immediate excision and grafting have also been shown to improve the adaptive immune system with restoration of antibody synthesis to bacterial antigens, suggesting that earlier excision may decrease risk of bacterial infections in burn patients.[18] Fear and colleagues[19] reported that early excision is less disruptive to the immune response by looking at markers for the innate and adaptive immune system. This study suggests that early excision during the phase of immune down-regulation initiated by the burn trauma maintains the innate and adaptive immune cell responses compared with delayed excision, which causes these to be down-regulated.

To this day, no exact recommendation for timing of early excision or safe percentage of burn to excise has been elucidated (**Table 1**). Common