

Third-Degree Burn Management in Surgery

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ABSTRACT

Third-degree (full-thickness) burns are severe injuries characterized by complete destruction of the epidermis and dermis, eliminating the intrinsic regenerative capacity of the skin and necessitating surgical intervention for definitive management. Contemporary treatment is based on early resuscitation, prompt excision of necrotic tissue, definitive wound coverage, and structured long-term rehabilitation. Early excision and split-thickness skin grafting (STSG) remain the gold standard, significantly reducing mortality, infection, and hospital stay. Advances in dermal substitutes and bioengineered skin have expanded reconstructive options in extensive burns. A multidisciplinary approach is essential to optimize survival, functional outcomes, and long-term quality of life.

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INTRODUCTION

Full-thickness burns extend through the entire dermis and destroy adnexal structures, preventing spontaneous re-epithelialization and making surgical reconstruction mandatory. These injuries are associated with significant morbidity due to systemic inflammatory response, high susceptibility to infection, and long-term sequelae such as contractures and hypertrophic scarring. Over recent decades, management strategies have evolved from delayed conservative approaches toward early aggressive surgical intervention, which has been consistently associated with improved survival and functional outcomes (1,2).

PATHOPHYSIOLOGY AND CLINICAL RELEVANCE

Third-degree burns result in complete destruction of the epidermal and dermal layers, including loss of epithelial stem cells and adnexal structures. This leads to the formation of avascular eschar, impaired local immune response, and an increased risk of invasive infection. In extensive injuries, a systemic inflammatory response syndrome develops, characterized by capillary leak, fluid shifts, and a hypermetabolic state that can progress to multiorgan dysfunction (2,3). Clinically, burns involving more than 5% of total body surface area or affecting critical anatomical regions such as the face, hands, feet, perineum, genitalia, or

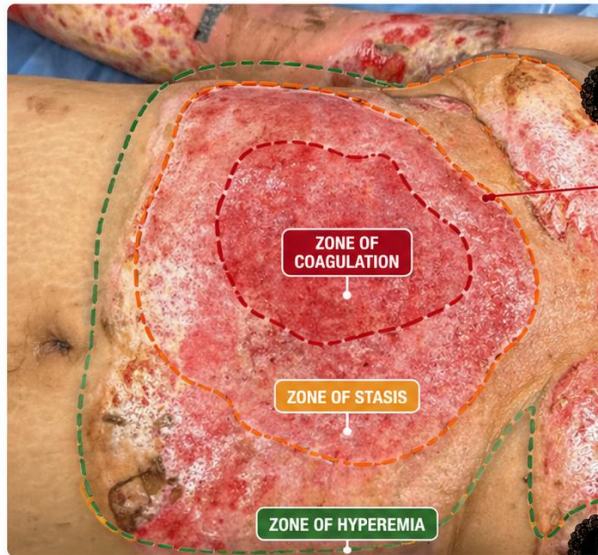
major joints require management in specialized burn centers due to their complexity and associated risks (1).

INITIAL ASSESSMENT AND RESUSCITATION

The initial management of patients with full-thickness burns follows standard trauma principles, prioritizing airway protection, breathing, and circulation. Early intubation should be considered in patients with suspected inhalation injury, as delayed airway compromise can be catastrophic. Fluid resuscitation remains a cornerstone of early management, with the Parkland formula widely used to guide initial therapy. This approach recommends administering 4 mL/kg per percentage of burned total body surface area within the first 24 hours, with half delivered during the first 8 hours and the remainder over the following 16 hours. However, resuscitation must be titrated according to physiological endpoints, particularly urine output, to avoid complications associated with both under-resuscitation and fluid overload, such as compartment syndromes and pulmonary edema (3,4).

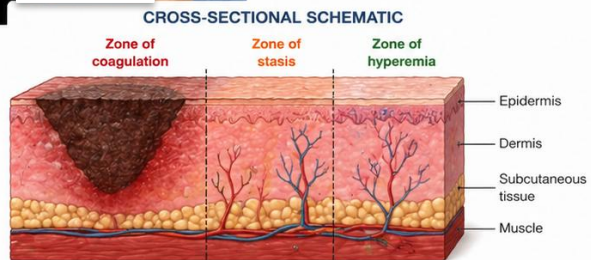
JACKSON'S ZONES OF BURN

Burns are not uniform in depth. Jackson (1953) described three concentric zones.



- ZONE OF COAGULATION**
(Central Zone)
Full-thickness injury.
All tissue is irreversibly damaged (epidermis, dermis, adnexal structures).
Will not heal spontaneously.
Requires excision and grafting.
- ZONE OF STASIS**
(Intermediate Zone)
Partial-thickness injury.
Tissue is viable but poorly perfused.
May progress to coagulation if untreated.
Potentially salvageable.
- ZONE OF HYPEREMIA**
(Peripheral Zone)
Superficial injury.
Markedly increased blood flow.
Will heal spontaneously.
Not at risk of progression.

KEY CHARACTERISTICS			
	ZONE OF COAGULATION	ZONE OF STASIS	ZONE OF HYPEREMIA
Depth of injury	Full-thickness	Partial-thickness	Superficial
Blood flow	None	Decreased	Increased
Viability	Non-viable	Marginal	Viable
Outcome (untreated)	Will not heal	May progress	Heals spontaneously
Management	Excision + graft	Resuscitation + time-dependent	Conservative



Accurate assessment of burn depth requires time (24–72 hours) for demarcation of zones.
Early excision typically includes the entire zone of coagulation and often part or all of the zone of stasis.

Surgical Management: Principles and Timing

The surgical management of third-degree burns is based on early debridement, definitive wound coverage, and subsequent rehabilitation. Early excision of necrotic tissue, ideally performed within the first 24 to 72 hours following injury, has been shown to significantly reduce mortality, infection rates, inflammatory burden, and hospital length of stay (5,6). The rationale for early excision lies in the removal of non-viable tissue that serves as a nidus for bacterial proliferation and perpetuates systemic inflammation.

Tangential excision remains the preferred technique, as it allows preservation of viable dermal elements while progressively removing necrotic tissue. In contrast, fascial excision provides a faster approach but is associated with greater blood loss and increased morbidity due to the sacrifice of viable tissue planes. More recently, hydrosurgical debridement systems have been introduced and may offer advantages in terms of precision and long-term scar quality, although their role remains adjunctive (7). In cases of circumferential burns, escharotomy or fasciotomy may be required to relieve compartment pressure and restore perfusion.

DEFINITIVE WOUND COVERAGE

Definitive closure of full-thickness burn wounds is essential to restore the skin barrier, reduce fluid loss, and prevent infection. Split-thickness skin grafting remains the gold

standard for coverage of third-degree burns and is considered the most effective and widely applicable technique (5–8). Early grafting has been associated with improved outcomes, including reduced rates of hypertrophic scarring and contracture formation. Clinical series have demonstrated significantly lower rates of severe scarring in grafted patients compared to those managed conservatively, with hypertrophic scarring reported in approximately 6% of grafted wounds versus up to 20% in non-grafted cases (8). In extensive burns or in patients with limited donor sites, adjunctive reconstructive strategies are frequently required. These include the use of temporary allografts, dermal substitutes, and bioengineered skin equivalents, which serve to optimize the wound bed and facilitate subsequent autografting. Advances in regenerative medicine, including spray-on epithelial cell technologies, have further expanded the reconstructive armamentarium, although these techniques currently complement rather than replace autologous grafting (7,9).

SPECIAL CONSIDERATIONS

Lower extremity burns represent a particular challenge due to their association with functional impairment and increased risk of complications. These injuries almost invariably require surgical intervention, often employing a staged approach consisting of early excision, temporary coverage

with allograft, and subsequent definitive autografting once the wound bed is optimized (10). Similarly, burns involving functional areas such as the hands and joints require early and aggressive management to preserve mobility and prevent contracture formation.

PAIN MANAGEMENT

Despite the insensate nature of full-thickness eschar, patients experience significant pain originating from surrounding viable tissues and procedural interventions such as dressing changes and grafting. Effective pain management requires a multimodal approach combining opioid and non-opioid analgesics, as well as adjunctive therapies. Emerging non-pharmacological interventions, including virtual reality-based distraction techniques, have shown promise in reducing procedural pain, particularly in pediatric populations (11).

REHABILITATION AND LONG-TERM OUTCOMES

Rehabilitation is initiated early in the course of treatment and continues throughout recovery. The primary goals are to

preserve range of motion, prevent contractures, and optimize functional outcomes. Scar modulation strategies, including compression therapy, silicone applications, corticosteroid injections, and laser treatments, play a critical role in minimizing hypertrophic scarring. Long-term follow-up is often necessary, as many patients require secondary reconstructive procedures to address functional limitations and aesthetic concerns. Additionally, psychosocial support is an essential component of comprehensive burn care due to the significant emotional and psychological impact of these injuries (12–15).

COMPLICATIONS

Complications following third-degree burns include infection, graft failure, hypertrophic scarring, contracture formation, chronic pain, and dysesthesia. Systemic complications such as sepsis and multiorgan failure remain significant causes of mortality in severe cases. Early recognition and aggressive management of these complications are essential to improve outcomes.

Aspect	Recommendation / Strategy	Surgical Rationale	Clinical Impact
Timing of excision	Early excision within 24–72 hours	Removes necrotic tissue, decreases inflammatory mediators and bacterial load	↓ Mortality, ↓ infection, ↓ length of stay
Type of excision	Tangential excision (preferred)	Preserves viable dermis, allows stepwise depth control	Better graft take, improved functional/aesthetic outcomes
	Fascial excision (selected cases)	Rapid removal of deep burns	Useful in extensive burns but ↑ morbidity
Eschar management	Escharotomy for circumferential burns	Relieves vascular compromise and compartment pressure	Prevents ischemia and limb loss
Definitive coverage (gold standard)	Split-thickness skin graft (STSG)	Restores barrier function and accelerates wound closure	↓ infection, ↓ fluid loss, ↓ scarring
Temporary coverage	Allograft (cadaveric skin)	Biological dressing for wound bed preparation	Useful in large TBSA or unstable patients
Adjunctive reconstruction	Dermal substitutes (e.g., bilayer matrices)	Provides dermal scaffold prior to grafting	Improves elasticity and scar quality

	Bioengineered skin / epithelial cells	Expands coverage in limited donor sites	Reduces donor site morbidity
Staged reconstruction	Excision → temporary coverage → delayed autograft	Allows physiologic stabilization and wound optimization	Standard in extensive burns
Lower extremity burns	Early excision + staged grafting	High risk of complications and functional loss	Improves limb salvage and mobility
Functional areas (hands/joints)	Early coverage + aggressive rehab	Prevents contractures and stiffness	Preserves function
Re-grafting / revision	Secondary grafting if failure or loss	Addresses partial graft take or infection	Improves final outcome
Scar modulation (surgical)	Contracture release, Z-plasty, flaps	Corrects deformity after healing	Restores function and contour

DISCUSSION

The management of third-degree burns has undergone a paradigm shift toward early aggressive surgical intervention combined with optimized critical care. Among all treatment strategies, early excision and grafting remain the most impactful interventions in reducing morbidity and mortality. While emerging technologies in tissue engineering and regenerative medicine offer promising future directions, their current role is primarily adjunctive. Continued advances in surgical techniques, critical care, and rehabilitation are expected to further improve outcomes in this complex patient population.

Conclusion

Optimal management of third-degree burns requires a structured, multidisciplinary approach that includes early resuscitation, timely surgical excision, definitive wound coverage with split-thickness skin grafting, and long-term rehabilitation. This integrated strategy is essential to maximize survival, preserve function, and improve quality of life in patients with severe burn injuries.

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