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Review

Current concepts on burn wound conversion—A review of recent advances in understanding the secondary progressions of burns

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ABSTRACT

Burn wound conversion describes the process by which superficial partial thickness burns convert into deeper burns necessitating surgical intervention. Fully understanding and thus controlling this phenomenon continues to defy burn surgeons. However, potentially guiding burn wound progression so as to obviate the need for surgery while still bringing about healing with limited scarring is the major unmet challenge. Comprehending the patho-physiologic background contributing to deeper progression of these burns is an essential prerequisite to planning any intervention. In this study, a review of articles examining burn wound progression over the last five years was conducted to analyze trends in recent burn progression research, determine changes in understanding of the pathogenesis of burn conversion, and subsequently examine the direction for future research in developing therapies. The majority of recent research focuses on applying therapies from other disease processes to common underlying pathogenic mechanisms in burn conversion. While ischemia, inflammation, and free oxygen radicals continue to demonstrate a critical role in secondary necrosis, novel mechanisms such as autophagy have also been shown to contribute affect significantly burn progression significantly. Further research will have to determine whether multiple mechanisms should be targeted when developing clinical therapies.

Contents

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1. Introduction

Over the last ten years, more than 190,000 patients have been admitted for acute burns in the United States with 24,591 patients admitted in 2013 alone [1]. The majority of these cases involved a small total body surface area (TBSA). However, those patients with higher percent TBSA burns had significantly increased mortality in all age groups [1]. While the direct damage to the tissue area caused by the primary injury is often irreversible, the secondary insult caused by progression of the burn wound is amenable to therapeutic intervention.

Burn wound conversion can be defined as the progression of superficial partial-thickness burns to deep partial-thickness and full-thickness burns [2]. This concept originates in the traditional description of burn injury zones by Jackson, in which three different zones of tissue damage of varying degrees occurred after burn injury [2]. The central irreversibly damaged zone of coagulation, the surrounding damaged but threatened zone of stasis, and the outermost recoverable zone of hyperemia. The middle zone of stasis was noted to be viable by Jackson [3] and has since been deemed a therapeutically critical section of burn surface area to address as it loses perfusion in its natural course, dies, and regresses into the inner zone of coagulation that cannot be salvaged [2]. The issue of progression of injury in the zone of stasis is pivotal since burn wound conversion often contributes to both greater burn surface area and burn depth. This larger, deeper wound has multiple local and systemic consequences that increase complications and morbidity [4–6].

As halting the progression of damage in the zone of stasis is a logical point of medical intervention in burn treatment, much research has been devoted to better understanding the process of burn conversion, and halting it. A recent review found 29 studies in 2012–2013 investigating experimental burn conversion treatments [7]. While several advances have been made in elucidating new mechanisms of burn progression, some of the leading theories behind secondary burn damage have remained the same for many years. Microthrombosis was noted in burn wounds in 1949 [8] and shortly thereafter found to be reversible to prevent necrosis of otherwise viable burn tissue [9]. The importance of reactive oxygen species (ROS), such as hydrogen peroxide and hydroxyl radicals, as mediators of tissue injury post-burn has also been known for some time [10]. On the other hand, more recent data has recognized the importance of other mechanisms, such as autophagy, in contribution to burn wound progression [11]. Though our understanding of burn wound progression pathogenesis is changing, the principles and applications of burn treatment have remained fairly stable.

Current therapies in medical burn wound treatment after stabilization and prior to reconstruction are aimed at treating the complications of burns, promoting healing, and preventing further complications. Fluid resuscitation serves as the mainstay of systemic treatment in moderate and severe burns to maintain organ and tissue perfusion. Local wound management includes topical antibiotics and various biologic and non-biologic dressing as means of protection from the environment, drainage absorption, pain control, and providing a moist environment for wound healing [5,12]. Though such treatments may have secondary effects on wound conversion [13], as the pathogenesis of burn wound progression is still not well understood, few clinical therapies are designed to directly address the issue of wound progression.

The purpose of this study is to investigate the recent progress in understanding the pathophysiology of burn wound conversion. Elucidating the trends in burn wound progression research may help provide a better understanding of whether therapeutic interventions for halting burn progression will continue to be targeted towards conventional therapies or whether new treatments might offer increased efficacy.

2. Materials and methods

A review of the current literature was conducted to identify recent studies on the pathogenesis of burn wound conversion. A literature search was performed by querying the MEDLINE database for full-text articles over the last five years (2010–2014) using the keywords, ''burn AND wound AND (conversion OR progression OR expansion)''. A preliminary review of article titles was used to include any basic or clinic science studies on burn progression. Review articles, articles in languages other than English, and abstracts were excluded from the study.

We identified abstracts focusing specifically on the pathophysiology of burn wound conversion, either proposing new theories or expanding on previously known mechanisms of burn progression. Full texts were then categorized according to the particular burn conversion pathophysiology investigated in each article. Studies describing new potential treatments for already defined mechanisms of progression were also addressed.

3. Results

The initial search criteria yielded a total of 254 potential articles for the time period of 2010–2014. After screening titles