Hand Burns

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Hand burns occur commonly both as part of larger burn injuries as well as isolated injuries and are a leading cause of impairment after burn injury.[1] However, there continues to be an overwhelming number of unanswered questions in nearly every facet of hand burn management. Even the issue of optimal timing for skin closure, which seemed to have been well answered, has been called into question, and recent articles suggest that even this fundamental question may require further exploration.[2] Other aspects of hand burn management, including graft types (ie, full vs split thickness), postoperative positioning, use of Kirshner wires, timing for range of motion, and use of splinting, remain unresolved. The analysis of hand outcomes also has been an ongoing challenge, primarily because of the lack of validated assessment tools that correlate the extensive data one can collect on range of motion at each joint, hand strength and sensation with overall functional outcome. The purpose of the hand panel was to identify gaps in our knowledge in several different aspects of hand burn management and identify specific priorities for future research in the broad and complex domain of hand burns.

BACKGROUND

Hand burns occur quite commonly, and the outcome of hand burns can significantly impact daily function and overall health-related quality of life. The management of hand burns is typically dictated by the depth of the burn. Superficial and partial-thickness burns that are likely to heal within a timely manner (2 to 3 weeks) are managed with wound care and aggressive range of motion to preserve hand function. Conversely, deeper partial-thickness and full-thickness burns that will require longer time to heal are better managed with wound excision and skin grafting. There have been a number of studies that have examined the optimal management and outcomes of patients with both partial-thickness and full-thickness burns of the hand. Sheridan studied 305 hands with partial-thickness tissue loss that did not require surgery and found that 97% of patients had good functional outcome defined as normal or near normal based on staff impression.[3] These findings contradict the opinion of "universally" good outcomes for this burn depth and suggest that more studies are needed to try to determine the sources of suboptimal outcome after partial-thickness injuries (ie, patient compliance with therapy, chronic pain).

Many of the studies on surgical management of hand burns have focused on the timing of excision and the techniques of skin grafting. Full-thickness hand burns have been described as having mostly good outcomes.[3] van Zuijlen's evaluated the outcome of 88 patients (143 hand burns) using the Jebsen Taylor Hand Test and found 80% of the hands had normal function on all 7 tasks.[4] No distinction was made for joint ankylosis or exposed or rupture tendons, and there was no correlation found between surgery timing and outcome. Only three patients in the series underwent amputation, and these patients tended to have greater functional impairment.[4] Sheridan studied 309 hands with deep dermal or full-thickness injuries that required grafting.[3] Of these, 81% had normal or near-normal function based on staff impression, but no formal functional assessment or range of motion measurements were performed. Eighteen percent could perform activities of daily living (ADL) with adaptive equipment, and less than 1% of the hands were unable to perform ADL.[3] Cartotto[5] evaluated 29 patients with deep partial- or full-thickness hand burns. At greater than a year after injury, these subjects had normal mean pinch strength but decreased grip strength and a mean TAM of 225 degrees, which is considered functional but is clearly

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well below the norm of 260 degrees. Although early excision and grafting is standard for full-thickness hand burns, factors such as TBSA, medical stability, and other complicating conditions may impact the timing of surgery, other management strategies, and ultimate outcome.

Deep full-thickness hand burns involving the extensor mechanism, joint capsule, or bone are rare, comprising less than 5% of all hand burns, but have been described as having universally poor outcomes regardless of treatment.[6,7] Sheridan et al[3] studied 56 hands with fourth-degree injuries. Their protocol included immobilization with axial Kirschner wires with staged autografting when avascular structures were covered with granulation tissue. The majority of patients (89%) required Kirschner wire fixation, and 61% required one or more partial or complete digital amputations. Of this group, only 9% had normal or near-normal hand function, 81% could perform ADLs with equipment, and 9% were unable to perform ADLs. Although these findings are consistent with the clinical impressions of the burn community, no actual functional assessments were performed. Holavanahalli et al[8] studied 32 burn survivors with deep full-thickness hand burns. They found severe impairment with more than 50% amputations and 22% with a Boutonniere deformity. Forty percent of subjects had poor functional range, with a TAM of less than 180 degrees. Scores on Jebsen Taylor Hand Test were lower than the norms, and subjects reported most difficulty in performing MHQ-Activities of Daily Living. These data clearly demonstrates the profound impairments found with this depth of burn. It is obvious that this group requires extensive research to find better ways of protecting the tendons and maximizing functional outcomes.

Regardless of burn depth, range of motion therapy and timing of splint immobilization are important considerations throughout the early and late postinjury period. An experienced burn hand therapist is an essential member of the burn team. Aggressive range of motion should be started soon after admission to the burn center for most partial- and full-thickness hand burns. For patients who are unable to actively participate because of the extent of injury or other factors, therapy staff should perform regular passive range of motion.

Long-term hand outcome typically is influenced by a number of factors, including formation of hypertrophic scar, joint contracture, lack of compliance with therapy regimen, pain, and neuropathy. There have been few studies that have provided a longitudinal assessment of hand function after burn injury, and most of the literature on long-term outcome after hand burns focuses on techniques for correction of scar contractures. In addition, there have been few studies examining the best methods for assessing hand function. In Johnson et al's review of hand function after deep burn injury,[9] they recommends using the total active motion measurement to assess outcomes. The classification system for this tool is: poor $<$180 degrees, good 180–219, excellent 220–259, and normal 260 degrees. The technique is discussed, but no actual patient data are given. In addition, there are a number of range of motion and strength measurements that are routinely obtained, yet it is not clear which are the most useful for assessing functional status. A number of the outcome tools used have not been validated for burn injury, and it is unclear whether they are sensitive to the issues burn patients have and whether they are responsive to progress in hand function over time.

WHAT IS NOT KNOWN

Despite being such a common injury, there is much that still needs to be known about hand burns. Hand burn management encompasses a number of overlapping issues, including surgical management, splinting, pain management, scarring, and digit/hand salvage. Within each domain of hand burn management, there are several important questions that remain unanswered.

INITIAL TREATMENT AND SURGICAL MANAGEMENT

There are many critical considerations in the early management of hand burns. The indications and timing for carpal tunnel release after electrical injury still has yet to be determined. In cases of deep digital burns, the relative benefits of digital escharotomy have yet to be clearly defined. Although early excision and grafting have become the standard management for burns that will not heal in a timely fashion, there are still many unanswered questions about the details of surgical management. For example, the best type of skin graft coverage (ie, split- vs full-thickness grafts; sheet vs mesh grafts) and how to position the hand for grafting are not clear. In addition, the indications and optimal use for skin substitutes such as Integra needs to be determined.

DEEP HAND BURNS

The improved survival of patients with severe burn injury has resulted in an increased number of patients

who have deep hand burns with exposed tendon and/or bone. These injuries present a number of challenges to the burn team. The overall goal of hand burn management is to optimize hand function, but there are few studies and little information to help guide management decisions in cases of deep hand burns. Clearly, there is a need to know how the exposed tendon and/or joint should be treated. During the period before grafting, the ideal dressings for keeping exposed tendons viable needs to be known. In addition, the ideal splinting position and range of motion protocol for hands with exposed tendons and joints needs to be known. There are also many unanswered questions related to the surgical management of deep hand burns. For example, should early arthodesis be performed on all exposed joints? Should treatment vary if only one joint is exposed as opposed to all joints on all digits? The answers to these questions require an understanding of the relative functional impairment associated with arthrodesis as compared to Boutinerre and swan neck deformities. The potential role of skin substitutes and flaps in providing coverage for traditionally bones and tendons traditionally considered to be non-graftable also needs to be examined. The decision between hand/digit salvage and amputation also warrants further study. Clearly, the decision for amputation will be influenced by a number of other patient and injury characteristics, including age, hand dominance, and extent of burn injury, however, the need to define the optimal timing for amputation and the impact of proximal elbow and hand wrist function on the decision to amputate remains. Finally, the role of prosthetics in the management of deep hand burns needs to be evaluated.

PAIN AND NEUROPATHY

Hand pain and neuropathy will significantly impact hand function both in the early postinjury period as well as during the rehabilitation phase of care. The pathophysiology of chronic hand pain and neuropathy following burn injury are not clear. Although the causes are multifactorial, the ability to identify patients at risk for neuropathy and the development of strategies to mitigate modifiable risk factors would clearly be beneficial. In addition, research is needed to determine the best methods for management of neuropathy, chonic pain, and complex regional pain syndrome. Because these complications occur relatively rarely, there are few studies examining the management of these issues.

EXERCISE AND ROM THERAPY

Most agree that consideration of hand positioning and range of motion exercises is required early in the post-injury period. However, few data are available on the optimal timing and frequency of hand exercises and the balance between immobilization to maintain optimal hand positioning and range of motion to prevent stiffness. In addition, many different approaches to splinting (ie, dynamic splinting, casts) have been described but few have been rigorously evaluated.

OTHER LONG-TERM SEQUELAE

The management of hand burn complications can continue for years after the initial injury. Scar contractures—both those isolated to the skin and those involving tendons and joints—can be the source of hand impairment. There have been few studies examining the optimal management of these secondary deformities. In addition, nail deformities occur quite commonly in the setting of hand burns and can be a source of both pain and disfigurement. Very little is known about these deformities and the best methods for managing them.

OUTCOME MEASUREMENTS FOR HAND FUNCTION

There are a number of important logistical considerations that need to be addressed in order to effectively study many of the issues discussed above. The development of rigorous studies that will provide meaningful results is contingent on having well defined outcome parameters and tools that can effectively capture them. There is an overwhelming volume of data that can be collected including individual joint active and passive motion, hand strength, nerve conduction studies, and sensation thresholds, yet the correlation between results of these tests and hand function has not been defined. There is a clear need to develop a set of functional assessment tools that is valid for persons with hand burns.

CONCLUSION

In 2000, Salisbury[6] outlined the most common deformities seen after hand burns: webspace contractures, dorsal skin contractures, fifth finger abduction deformity, MP joint extension deformities, extensor tendon adhesions, Boutonierre deformity, PIP flexion deformities, neuropathy, amputation, and proximal influences. These common deformities persist

and many remain without well-described solutions. Given the critical importance of the hand to overall functional status, hypothesis driven, high quality research studies are needed evaluate the effects of different surgical and therapeutic approaches. The five priority topics for hand research are listed in Table 1 and are as follows:

1. Determining the best approach to management of the deep hand burn with exposed tendon.
2. Determining the role and benefit of skin substitutes in the management of hand burns.
3. Determining the optimal surgical approach to prevent and treat web space contractures.
4. Determining the optimal timing and components of burn hand therapy—including exercises and modalities.
5. Examining the factors that influence the outcome of partial thickness hand burns.

Successful conduct of these studies will likely require a cooperative group set up to perform multi-center trials and the dedication of appropriate resources to cover the infrastructure costs of performing such studies.

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