https://doi.org/10.55453/rjmm.2026.129.2.4

REVIEW

Diagnostic and Therapeutic Principles for Burns Involving Functional Areas: A Comprehensive Overview

Cristian-Sorin Hariga[1,2], Bogdan Marinescu[1,3], Ioan Lascar[2], Serban-Arghir Popescu[1,2], Adrian Frunza[1,2], Eliza-Maria Bordeanu-Diaconescu[2], Sabina Grama[2], Raducu-Andrei Costache[1,2], Matei Iordache[1,2,*], Andreea Grosu-Bularda[1,2]

[1] Department 11, Discipline Plastic and Reconstructive Surgery, "Carol Davila" University of Medicine and Pharmacy, 050474 Bucharest, Romania
[2] Clinic of Plastic Surgery and Reconstructive Microsurgery, Clinical Emergency Hospital of Bucharest, 014461 Bucharest, Romania
[3] Plastic Surgery and Reconstructive Microsurgery Clinical Department, "Dr. Carol Davila" Central Military Emergency University Hospital, Bucharest, Romania

*Correspondence: matei.iordache22@gmail.com

Abstract: Burns that affect functional areas present unique challenges in terms of diagnosis and therapy due to their particular mobility and aesthetic importance. In this article, we summarize the current principles in the diagnosis, treatment, and rehabilitation of burns that affect these regions. In this regard, the recent medical literature (clinical evidence) was analyzed to outline management strategies specific to each region. Early and correct evaluation of lesions, along with individualized treatment are essential for maintaining mobility and preventing sequelae. The results obtained are applicable in both civilian and military environments. Superficial burns respond well to conservative care with dressings, splints, and physiotherapy on the one hand, and on the other hand, deep burns benefit from excision and early grafting, the standard modern procedure that shortens hospitalization and greatly improves results. Long-term recovery depends on scar modulation, reconstructive surgery, and multidisciplinary rehabilitation addressing both functional and psychological aspects. Treatment of the burns of functional areas requires prompt, tailored, and multidisciplinary management to restore function and minimize disability. Standardized treatment algorithms and expanded research on long-term rehabilitation remain essential for improving burn care outcomes.

Keywords: burns, functional areas, face, hands, feet, perineum, joints, rehabilitation, reconstructive surgery, scar management

INTRODUCTION

Burns represent one of the most important types of trauma, being a public health problem and causing over 180,000 victims annually. The impact of this trauma is significant in civilian activity and much more important and frequent in military activity or in the case of conflagrations. The American Burn Association (ABA) and its European equivalent (EBA) have clearly mentioned as a severity factor the involvement of functional areas in burns, regardless of whether they have a large total affected area or not. Therefore, the need arose for an analysis of the specialized literature in the civilian field to evaluate and stratify the most recent recommendations on the treatment of these important and sensitive regions. Articles such as those mentioned above allow the development of a set of recommendations on the treatment of functional areas such as the hands, face, perineum, feet, and major joints, both in the civilian environment, where they were developed, and in the military field, by extrapolation, the pathology in question being similar.

MATERIALS AND METHODS

Purpose of the study

In this study, we sought to find the main therapeutic methods recently used for the surgical treatment of functional areas. Their treatment is of particular importance because these areas have complex functionality and often a major aesthetic impact, while a mediocre or a bad result would lead to a low quality of life for the surviving patients. The quality of the surgical treatment, despite not being the only aspect, is a decisive one in increasing the quality of life. The physiokinetotherapy and the psychological support are equally important, but do not constitute the subject of the

Citation: Hariga CS, Marinescu B, Lascar I, Popescu SA, Frunza A, Bordeanu-Diaconescu EM, Grama S, et al. *Diagnostic and Therapeutic Principles for Burns Involving Functional Areas: A Comprehensive Overview.* R. J. Mil. Med. 2026, CXXIX(2): 151-159 https://doi.org/10.55453/rjmm.2026.129.2.4

Academic Editor: Remus Nica

Received: 01 November 2025
Revised: 27 November 2025
Accepted: 05 December 2025

current research. Databases used: We used the most recent articles on this subject that have appeared in the specialized literature during the last years in WoS and PubMed, comparing this data to the general principles that still apply and that have been described in previous years. Data selection: We have selected only the articles in English regarding the treatment in the field of Plastic Surgery, both in the surgical period and in the rehabilitation period. We excluded the "Case Report" articles and those not concerning the functional areas due to their low relevance. The result of this research was a significant number of articles from which the most relevant and recent references were kept, resulting in 69. Data extraction: From the aforementioned sources, the surgical procedures and techniques were extracted, with the most indications from various authors based on the consistently good results obtained in the field of burns treatment and research. Other possible therapeutic options were not ignored either, as alternative solutions may be very useful in the more complex cases that affect multiple functional areas, with severe implications that derive and which also require a staged treatment. We also highlighted a series of very new surgical treatment procedures that seem promising and may become standard in the future, and also added the experience of the research group that conducted this study. Data analysis: The data obtained were structured on anatomical regions, so that for each of them, the particularities and therapeutic solutions are clear and nuanced. We have stated the therapeutic possibilities with the most indications and also other possible options. This enumeration can become a therapeutic algorithm for this pathology, with both civilian and military applicability.

RESULTS

1. THE BURNED HAND

The hand represents an anatomical region of particular importance due to its function in daily activities. It also plays a major role in communication and the expression of emotions, as well as from an aesthetic standpoint, since it is difficult to conceal. Its function is absolutely indispensable, especially in today's digital age, where any impairment of the hands could compromise or hinder interaction with the surrounding environment, leading to social and intellectual isolation of the individual suffering from burns in these areas [1]. This area is often the most frequently affected in cases of major burns, with hand burns occurring in over 80% of cases [2,3]. Due to the severe implications and the frequency of injury, it is natural and essential that these burns are included among the main admission criteria of the American Burn Association (ABA). The loss of hand function has a significant impact, and patients require assessment in specialized centers, as such injuries often lead to major disabilities, rendering the patient unable to perform their occupation or carry out daily activities [1]. Despite the fact that they account for less than 3% body surface on each side, the major impact of hand burns arises from the morbidity they can cause. Therefore, the therapeutic approach applied in these cases is crucial, as prioritization of these areas is often neglected. Treatment must begin immediately after the injury occurs and may involve a surgical approach - such as performing decompression incisions - or an initial conservative approach, followed later by other treatment methods, including covering the resulting defects, immobilization with splints (either for posture or to prevent shearing of grafted areas), closely accompanied by physiokinetotherapy with the main objective of preservation and restoration of hand function [2,4]. In a study conducted by Sheridan et al., normal hand function was successfully regained in 97% of patients with superficial partial-thickness burns and in 81% of those with deep partial-thickness or full-thickness burns [5].

Epidemiology

A retrospective study conducted in a major burn center in Southwest China over a five-year period (2012–2017) supports the data mentioned above, providing a series of statistical findings focused mainly on hand burn injuries [6]. Out of a total cohort of 470 patients, the majority affected were male, 73.62%, while the most frequently represented age group was children under 10 years old, accounting for 29.57%. Hand burns occurred in 60.21% of cases outside the workplace, and their frequency increased significantly during the cold season, over a 3–4 month period from December to March, representing 55.11% of all burns recorded in a year. The etiologic agents were flames in 40.42% of cases, electrical current in 30.85%, and hot liquids in 20.21%. Another valuable piece of information highlighted once again is the impact that burn depth and the lack of immediate cooling of the burned area have on unfavorable outcomes, increasing the risk of amputation and prolonging the hospitalization period. In conclusion, this study emphasizes not only the importance of injuries to functional areas, in this case, the hands, but also the crucial role of prevention in influencing the course of burn injuries [6].

Clinical and Pathological Features

Hand burns often occur as a protective reflex, when patients instinctively use their hands to shield their heads from flames or hot liquids. As such, most burns are located on the dorsal side of the hands and less so on the palmar side. Another important aspect to take into consideration is the difference between the dorsal and volar skin. The dorsal skin of the hand is thinner and more mobile, allowing flexion movements at the joints but also carrying a higher risk of deeper burns. In contrast, the volar skin is more resistant to pressure and significantly more resistant to thermal energy due to its greater thickness and well-developed stratum corneum. It adheres tightly to the palmar aponeurosis and contains a high density of sensory nerve endings (Meissner, Merkel, Vater-Pacini corpuscles), which explains the major sensory deficits that may result from injury to this region [7,8]. Regardless of the affected side, another anatomical peculiarity lies in the short distance between the skin surface and the underlying structures - blood vessels, nerves, tendons, and joints, making them particularly vulnerable to thermal injury [2].

Therapeutic Principles

The treatment of hand burns must meet several essential conditions: [2]

- Prevention of wound deepening and of new wound formation
- Rapid coverage of the burn wounds
- Early functional rehabilitation with preservation of active and passive movements
- Prevention of infection
- Prevention of loss of functional structures

Treatment Principles: [2]

- Assessment of the burn's size and depth
- Application of dressings appropriate to the burn degree
- Determination of treatment indication - conservative versus surgical
- Surgical treatment - including escharotomy, necrectomy, and reconstructive procedures with grafts or flaps
- Early physiokinetotherapy
- Use of posture splints
- Secondary and tertiary surgical corrections - when indicated

The first stage in the treatment of major burn patients involves a thorough examination to assess the depth of the lesions. Based on this evaluation, the appropriateness of surgical treatment is determined, or a conservative approach is chosen. Although clinical evaluation is often relied upon, it has been shown to be accurate in only 60–75% of cases, even when performed by an experienced plastic surgeon specializing in burns [2]. There are also adjunct methods to objectively assess burn depth, offering a broad range of options - from biopsy and histological evaluation to perfusion measurement techniques such as angiography, thermography, video microscopy, and laser Doppler imaging [9–15]. Since burn injuries represent an area of major clinical interest, numerous studies have addressed this topic for over 50 years. Treatment can be both conservative and surgical, with long-standing debates regarding the choice between them and the timing of surgical intervention - early excision and grafting versus delayed grafting.

Surgical Treatment

The first studies described since 1982 the importance of early excision and grafting in third-degree burns with limited surface area, while emphasizing that in extensive burns, priority should be given to covering large areas and minimizing fluid and heat loss [16,17]. This concept is still applied and studied in our days. A study performed in 2019 compared the effects of early versus delayed excision and grafting. Conducted between January 2013 and December 2015, the study included 50 patients with bilateral grade IIB hand burns. Postoperative follow-up over a 3-month period assessed both objective and subjective outcomes using the Michigan Hand Questionnaire. Variables analyzed included hand function, pain scale, limitation of daily activities, overall patient satisfaction, and aesthetic outcomes. Although graft take rates were similar between groups, early excision and grafting proved superior in terms of patient satisfaction, significantly shorter hospital stays, and lower treatment costs [18].

Conservative Treatment

One of the most important issues in hand burn management is the evolution toward the sequelae stage, characterized by joint contractures that limit finger movement. The main causes leading to this stage include the initial trauma (its intensity and duration of exposure), wound infection, improper wound coverage, prolonged immobilization, and incorrect positioning of the hand during immobilization [2]. Often, as a result of edema secondary to trauma and fluid resuscitation, a series of intrinsic minus-type deformities may develop: flexion of the radiocarpal joint, hyperextension of the metacarpophalangeal joints, and flexion fixation of the interphalangeal joints, with the thumb fixed in an adducted position [19]. This underscores the importance of maintaining the hand in an optimal "intrinsic plus" position from the very first day: the wrist flexed at 20–30 degrees, metacarpophalangeal joints flexed at 80 degrees, full extension of the interphalangeal joints, and maximal abduction of the thumb. In alert and cooperative patients, immobilization is often necessary only during the night, provided that active and passive physiotherapy is performed twice daily. This approach can significantly reduce the incidence of permanent contractures and deformities [20].

Sequelae Stage

Treatment of the sequelae stage should ideally begin from the very first moment, through prevention. However, if this stage develops despite all preventive measures, several therapeutic methods can be used to limit the formation of hypertrophic scars. Among the predisposing factors for hypertrophic scar formation are: young age, secondary infection, skin tension, anatomical location (certain areas such as the axilla, neck, and shoulder have a higher risk), and burn depth, with higher incidence in deep partial-thickness and full-thickness burns [21,22]. The treatment of choice is often surgical, involving excision of scars or modification of tension vectors to lengthen the restrictive scars that may otherwise fix joints in unfavorable positions. Modern adjunctive methods include the use of lasers, which aim to improve scar texture, thickness, color, and local pruritus [23].

Reconstruction of the hands

The main hand sequelae were described by Achauer and include: claw deformity, palmar contractures, web space deformities, hypertrophic scarring, impairment resulting from amputations, and nail bed injury. Treatment of the sequelae phase is typically undertaken after full scar maturation, since premature intervention may lead to increased inflammation and additional scar formation. Therefore, surgical treatment generally begins six months after the injury [23]. Most hypertrophic scar contractures are treated using local flaps, with Z-plasty being the technique of choice - commonly performed at 60-degree angles, thereby lengthening the scar by approximately 75% [24]. These flaps are robust and viable, provided they are not excessively thinned and that the underlying subcutaneous tissue is preserved. To reduce local morbidity, surgeons prefer performing multiple smaller flaps rather than fewer large ones, which are generally indicated for other areas such as the axilla [23]. Z-plasty can also be used to treat web space deformities or in the palmar area where tendons or bone structures are exposed, and skin grafts cannot cover the post-excisional defects. More severe cases may require the use of distant flaps [25-28]. An interesting aspect related to patient perception concerns objective measurement tools for evaluating hand recovery. According to the American Society for Surgery of the Hand (ASSH), the Total Active Motion (TAM) is calculated for each finger by summing the degrees of active flexion and subtracting the sum of extension deficits across all joints. Although a normal value is around 260 degrees, patients often tolerate moderate decreases well and may still rate their hand function as “good” or “almost as good as before the injury.” Literature suggests that even a TAM value of 112 degrees is sufficient for performing most daily activities. Thus, patients may experience a notable reduction in this objective measure without perceiving a functional deficit in everyday tasks [29].

2. CEPHALIC EXTREMITY

The face represents an area of great interest, being the second most frequently affected functional region in burn injuries. The treatment of deep facial burns presents numerous challenges due to the anatomical complexity and functional diversity of this relatively small region. No standardized treatment protocol has been established, and as a result, sequelae often appear long after the trauma, frequently with severe consequences [30]. There has long been controversy regarding the choice between conservative and surgical treatment. In this regard, several studies have been conducted comparing final aesthetic outcomes and functional considerations [31]. One such study divided patients into four groups: those treated conservatively, healing within 21 days, those healing in more than 21 days, the third group underwent excision and grafting within 18 days, and the last group was operated upon more than 18 days after the injury. The best overall outcomes were achieved in the group of patients who healed conservatively within 21 days. Among the remaining groups, better results were obtained in grafted patients, who showed superior aesthetic outcomes. With regard to functional outcomes, no significant differences were observed between the groups. The most common complications were microstomia and ectropion, both reported in 17 of the 27 patients included in the study [31]. A 2012 study analyzed data collected over 12 years (1999–2010), focusing on full-thickness skin grafting for multiple facial burns involving several aesthetic units. The scalp was most commonly used as the donor site, providing an excellent color and texture match with the recipient areas. However, many authors have also noted long-term complications such as: significant loss of sensation, ectropion, gaps between the grafted regions and the hairline, visible graft edges, and hypertrophic scarring in the perioral area extending to the chin [32].

Periocular Burns

Numerous studies have demonstrated the importance of these anatomical regions as they are frequently involved in facial burns [30,33]. A study conducted by Still et al. (1995) described that 230 of the total of 1527 patients (representing 15.06%) required an ophthalmologic consultation either due to the burns or due to preexisting pathologies. 9.36% of the patients required medical care, with half of them having bilateral involvement, 11 patients requiring skin grafting or tarsorraphy, thus highlighting the incidence and the sequelae that require a close collaboration with the ophthalmologists [12, 34].

Nasal Burns

The nose is a very important anatomical region for both its functional and aesthetic aspects. Because of its location, it forms a very visible and complex aesthetic unit with multiple subunits. Aside from the aesthetic aspect, just as important is the functional role that it has, the reconstruction being an important issue. This three-dimensional structure is a complex one that requires substantial skills and experience for an adequate reconstruction. As such, satisfactory results are attained only after several staged procedures that achieve social reintegration and good functionality as well [35-37]. Despite the fact that its importance is indisputable when trying to establish a reconstructive algorithm, this region falls in sequence after the treatment of the periorificial regions [38,39].

Orofacial Burns

Partial-thickness burns in these regions may be treated by conservative means, but this option is severely limited in the case of full-thickness burns. A 2015 study by Clayton et al. compared a group of 12 patients with full-thickness burns of the oral commissure to a control group of 120 individuals of similar age. The final outcome was measured by assessing maximum mouth opening along both vertical and horizontal axes. While initial restriction of movement was severe, by the end of conservative treatment, which included rehabilitation therapy, there was significant improvement. However, even after recovery, mobility remained substantially reduced

compared to the control group, and the average treatment duration was 550 days, with half the patients requiring more than two years of rehabilitation [20].

Surgical Treatment

The management of facial burns has unique particularities related to the specialized anatomy of this region, with local vascularization significantly superior to that of other body areas and a higher density of skin appendages, especially in men. Due to these characteristics, excision and grafting are often delayed until days 12–15, even in deep partial-thickness or full-thickness burns. Many superficial and intermediate burns can heal spontaneously without sequelae within 15 days. The main exception is carbonized lesions, which justify early surgical intervention [23].

Treatment of Facial Burn Sequelae

Treating the effects of facial burn sequelae is often a lengthy and staged process commencing with a thorough assessment of the patient's available skin capital. The best outcomes are obtained when treating a major unit with a minor subunit in the same procedure, rather than two major units that are adjacent [40]. Reconstruction is most commonly performed using skin grafts, ideally from donor areas with similar color and texture to the face, including hair-bearing skin when appropriate. Preferred donor sites include the expanded supraclavicular region or the inner arm, as these areas provide grafts that closely resemble facial skin. In contrast, skin from the abdomen or thighs tends to be darker or more yellowish, producing noticeable contrast and therefore being avoided whenever possible [41]. Grafts should not be expanded, as this increases the risk of unaesthetic scarring that can attract attention. Full-thickness skin grafts are preferred, with small incisions made using a No. 11 scalpel blade to facilitate adaptation and drainage [23]. Flaps are primarily used in the sequelae stage, with very limited indications in the acute phase, such as cases involving exposure of bone, blood vessels, nerves, or the eyeball. Their use in emergencies is rare, since initial treatment should preserve as much tissue capital as possible for future reconstructive procedures [23,41].

Infections Associated with Facial Burns

Infections represent a major cause of morbidity and mortality among patients with severe burns [42]. Burns involving the face and neck frequently require intubation, often performed before hospital admission, or are associated with inhalation injuries - both of which are recognized risk factors for pneumonia. According to a study by Cotte et al., among 152 patients, pneumonia developed early in the disease course in 58 cases (38.2%), with the majority of the patients being intubated pre-hospital (65%). Among the patients who arrived at the ICU without prior intubation, 84% required subsequent intubation, with an average duration of mechanical ventilation of 18.1 ± 32.5 days. The main pathogens implicated in the development of early post-burn pneumonia were: Staphylococcus aureus - 56.9%, Streptococcus pneumoniae – 19%, Haemophilus influenzae – 19% and Escherichia coli – 6.9% [43] The study concluded that pre-hospital intubation is associated with a higher risk of early-onset pneumonia, which in turn leads to a significant increase in mortality Just as well it must be admitted the fact that delaying intubation in such cases may lead to respiratory compromise which may be life threatening.

Burn Stigmata

The advances in medicine have led to improvements in the survival rates of patients with severe burns. That means a majority of them are facing permanent sequelae. As such, in the three main stages of recovery, they shall require support [44]. The first phase, the resuscitation one, brings uncertainty of survival, anxiety, delirium, confusion, fear associated with pain and sleep disturbances. The second phase, which is that of rehabilitation, is influenced by the need for repeated surgical interventions and painful dressing changes. The third phase commences after discharge and means the challenges these patients face to reenter society in their new condition [45-47]. As such, psychological support becomes equally important for the patient as it is for their family, which may have a modified dynamic by the attempts to conceal the patient, leading to a delay in reintegration. Efforts in this direction lead to strengthening of the family's cohesion, facilitate the patient's reintegration in society, and reduce interpersonal conflict [47,48].

Emerging Areas of Interest

Modern medicine has led to an improvement in survival rates, but also to a bigger percentage of patients with sequelae requiring rehabilitation. Severe facial burns can lead to complications such as ectropion, oral commissure contracture, loss of facial sensitivity, poor oral or dental hygiene, excessive salivation, speech articulation difficulties, and problems with intubation. Some of these complications can be managed conservatively through rehabilitative therapies aimed at restoring the functionality of physiological sphincters, improving speech and oral control, and ultimately enhancing quality of life for facial burn survivors [49].

3. PERINEUM

The perineal region is an anatomically and functionally important area in the management of major burn patients. The ABA includes burns of this region among the major admission criteria, with the incidence of perineal burns ranging between 1.7% and 13% of all hospital admissions. These burns most frequently occur in patients with extensive total body surface area (TBSA) involvement, estimated between 21% and 56%, even though the external genitalia represent only about 1% of the total body surface. The perineum

is a region of particular concern because of its high association with urinary tract infections, an increased risk of nosocomial infections, and a higher recorded mortality rate among affected patients [50–52]. In terms of surface area, the external genitalia account for approximately 1% of the total body surface, while the entire perineal region comprises about 4–6%. Anatomically, this region is relatively protected from direct thermal injury, so isolated perineal burns are rarely described. When they do occur, they are most often associated with burns of the thighs and lower abdomen. Perineal burns occur more frequently in male patients and are associated with higher mortality, longer hospital stays, and an increased risk of secondary infection [53]. Treatment of perineal burns can be divided into two main approaches: conservative and surgical. Large-scale studies in the literature, such as the one conducted by Harpole et al., analyzed 71,895 patients, of whom only 1,245 had perineal burns (representing 10.4% of total cases). The authors recommended conservative treatment for the majority of cases, reserving surgical intervention - specifically excision and skin grafting - for patients with third-degree (full-thickness) burns [54].

4. BURNS OF THE FEET

Despite representing a small percentage of TBSA, burns to this region may lead to severe functional and clinical impact, more so in patients with high-risk conditions, such as those suffering from diabetes, which also heal more slowly. Early detection of the burns, optimal wound management, and good glycemic control may prevent deepening of superficial burns and avoid the need for excision, grafting, or amputation. A study by Jason Diab et al. described a higher incidence of these patients in the cold season, with a 1.7 times higher chance of burns in the winter (usually by hot liquid) compared to the non-diabetic patients, who mostly had burns in the warm season [55-57]. The goal is to reduce edema, pain, restore normal function and allow early mobilization. The treatment is often prolonged and usually requires a multidisciplinary approach with a diabetologist and endocrinologist consultations as well. The local management means cleansing and debridement, prevention of infection and bacterial colonization, pain control, and offloading pressure from the burned areas, which promotes healing by optimal moisture balance and support for epithelialization [58].

Conservative Treatment

The main objective is to prevent the formation of contractures, commissural closure, or macerations and ulcerations. This is obtained by balancing the exudate, reducing inflammation, and facilitating debridement while offering an adequate antimicrobial coverage and protecting the burned area [59]. One of the most important regions that needs protection is that of the ankle, which lacks means of defending itself due to a lack of an abundant adipose layer or muscular protection. The sequelae to this region may lead to gait abnormalities, posture modification, as well as pelvic and spinal deformities. Surgical treatment requires the excision of the scar tissue and tension vector modification by use of several Z-plasties, which can also be accompanied by the use of skin grafts to regain mobility and function [60,61].

5. MAJOR JOINTS

The huge impact that the burns to these regions bring makes prevention even more important. Once the burns have been described, the treatment is dependent on the degree. The more superficial ones are treated conservatively by epithelialization promotion using dressings developed for burns, dermal substitutes and splints. The deeper burns require early excision and grafting or the use of local flaps [62-64]. Due to the important functional consequences and major systemic response, these patients often require immobilization for a long period of time, which brings along a higher risk of contracture formation. Despite the fact that any joint may be affected by this, the joints that are most prone to deformities are the elbow, the shoulder, the hip, and the knee [65]. Even so, it is crucial to use posture splints in some cases. Studies have shown that splints significantly reduce the incidence of scar contractures, particularly when used for at least six months. Patients who refuse splinting or for whom splints were not prescribed are far more likely to require reconstructive surgical interventions later on [66]. In severe burns, extensive soft tissue defects with exposure of joints or bone may occur, requiring complex reconstructive techniques, such as local or distant flap coverage. These situations are most frequently reported following electrical burns [67]. Progression to the sequelae stage of joint involvement has been described in approximately one-third of patients with articular burns. Despite its prevalence, the specialized literature has not yet established a standardized protocol that accounts for the specificities of each anatomical region, and therefore, a comprehensive set of recommendations remains lacking [68]. It is, however, universally accepted that surgical treatment of scar contractures should only begin after the metabolic activity of the scar has ceased - typically more than one year after wound healing. As such, the risk to develop contractures is severely reduced [69].

CONCLUSION

Burns that affect functional areas represent a major therapeutic challenge, which has direct implications on the survival rate but especially on the long-term quality of life of survivors. The management of burns in these regions requires a multidisciplinary approach that integrates early assessment, appropriate prompt intervention and sustained rehabilitation. Despite significant advances in reconstructive surgical techniques and refined physiokinetotherapeutic protocols, the prevention of functional and aesthetic sequelae remains a difficult goal to achieve. The analyzed literature emphasizes the importance of early, individualized treatment plans adapted to the functional requirements specific to each anatomical region. Moreover, the psychosocial dimension of recovery after burns should not be underestimated, since rehabilitation after post-traumatic stress and disfigurement, as well as subsequent social

reintegration, presents a continuous, long-term activity that requires complex multidisciplinary care. Future research should focus on: standardization of treatment algorithms for functional areas; improving the quality of post-combustion scars; improving rehabilitation techniques; last but not least, the extension of long-term tracking data, in order to optimize the results through further research.

Conflicts of interest and sources of funding

The authors declare no conflict of interest

This research received no external funding

Acknowledgments

None

Authors' contribution

Conceptualization: Cristian-Sorin Hariga, Matei Iordache, Bogdan Marinescu; validation: Ioan Lascar; investigation: Serban-Arghir Popescu, Adrian Frunza, Eliza-Maria Bordeanu-Diaconescu, Sabina Grama; data curation: Andreea Grosu-Bularda, Matei Iordache; writing— Matei Iordache, Raducu-Andrei Costache; writing—review and editing, Cristian-Sorin Hariga; supervision, Ioan Lascar; project administration: Andreea Grosu-Bularda.

All authors have read and agreed to the published version of the manuscript.

Ethics approval and consent to participate

Not applicable (Review article)

Patient consent for publication

Not applicable.

References

1. Derek Culnan. Acute and Reconstructive Care of the Burned Hand. In: Herndon, Total Burn Care, 5th Edition, Elsevier, 2018

2. Kamolz LP, Kitzinger HB, Karle B, Frey M. The treatment of hand burns. Burns. 2009;35(3):327-37. doi: 10.1016/j.burns.2008.08.004.

3. Luce EA. The acute and subacute management of the burned hand. Clin Plast Surg. 2000n;27(1):49-63.

4. PEACOCK EE. Management of conditions of the hand requiring immobilization. Surg Clin North Am. 1953:1297-1309. doi: 10.1016/s0039-6109(16)34035-x.

5. Sheridan RL, Hurley J, Smith MA, Ryan CM, Bondoc CC, Quinby WC Jr, Tompkins RG, Burke JF. The acutely burned hand: management and outcome based on a ten-year experience with 1047 acute hand burns. J Trauma. 1995;38(3):406-11. doi: 10.1097/00005373-199503000-00022.

6. Liu M, Zhu H, Yan R, Yang J, Zhan R, Yu X, Hu X, Zhang X, Luo G, Qian W. Epidemiology and Outcome Analysis of 470 Patients with Hand Burns: A Five-Year Retrospective Study in a Major Burn Center in Southwest China. Med Sci Monit. 2020;26:e918881. doi: 10.12659/MSM.918881.

7. Schmidt H-M, Lanz U. Chirurgische Anatomie der Hand. 2., überarb. und aktualisierte Aufl. ed. Stuttgart: G. Thieme; 2003.

8. D. Morel Fatio, Surgery of the skin, R. Tubiana (Ed.), The hand, WB Saunders, Philadelphia (1961), pp. 224-225

9. M. Godina, M. Derganc, A. Brcic, The reliability of clinical assessment of the depth of burns, Burns, 4 (1978), pp. 92-96

10. Heimbach DM, Afromowitz MA, Engrav LH, Marvin JA, Perry B. Burn depth estimation--man or machine. J Trauma. 1984;24(5):373-8.

11. Droog EJ, Steenbergen W, Sjöberg F. Measurement of depth of burns by laser Doppler perfusion imaging. Burns. 2001;27(6):561-8. doi: 10.1016/s0305-4179(01)00021-3.

12. Watts AM, Tyler MP, Perry ME, Roberts AH, McGrouther DA. Burn depth and its histological measurement. Burns. 2001;27(2):154-60. doi: 10.1016/s0305-4179(00)00079-6.

13. Kamolz LP, Andel H, Haslik W, Donner A, Winter W, Meissl G, Frey M. Indocyanine green video angiographies help to identify burns requiring operation. Burns. 2003;29(8):785-91. doi: 10.1016/s0305-4179(03)00200-6.

14. Jeng JC, Bridgeman A, Shivnan L, Thornton PM, Alam H, Clarke TJ, Jablonski KA, Jordan MH. Laser Doppler imaging determines need for excision and grafting in advance of clinical judgment: a prospective blinded trial. Burns. 2003;29(7):665-70. doi: 10.1016/s0305-4179(03)00078-0.

15. Monstrey S, Hoeksema H, Verbelen J, Pirayesh A, Blondeel P. Assessment of burn depth and burn wound healing potential. Burns. 2008;34(6):761-9. doi: 10.1016/j.burns.2008.01.009.

16. Goodwin CW, Maguire MS, McManus WF, Pruitt BA Jr. Prospective study of burn wound excision of the hands. J Trauma. 1983;23(6):510-7. doi: 10.1097/00005373-198306000-00012.

17. Krizek M, Robbe M, Bilterys L, Vandenbussche F. Treatment of 100 burned hands by early excision and skin grafting. Ann Chir Main. 1982;1(2):125-36. doi: 10.1016/s0753-9053(82)80068-9.

18. Ayaz M, Karami MY, Deilami I, Moradzadeh Z. Effects of Early Versus Delayed Excision and Grafting on Restoring the Functionality of Deep Burn-Injured Hands: A Double-Blind, Randomized Parallel Clinical Trial. J Burn Care Res. 2019;40(4):451-456. doi: 10.1093/jbcr/irz033.

19. H.B. Kitzinger, U. Lanz, Die Anatomie der Fingergelenke, DAHTH, 6 (2004), pp. 3-11

20. Prasad JK, Bowden ML, Thomson PD. A review of the reconstructive surgery needs of 3167 survivors of burn injury. Burns. 1991;17(4):302-5. doi: 10.1016/0305-4179(91)90044-h.

21. Butzelaar L, Ulrich MM, Mink van der Molen AB, Niessen FB, Beelen RH. Currently known risk factors for hypertrophic skin scarring: A review. J Plast Reconstr Aesthet Surg. 2016;69(2):163-9. doi: 10.1016/j.bjps.2015.11.015.

22. McKee DM. Acute management of burn injuries to the hand and upper extremity. J Hand Surg Am. 2010;35(9):1542-4. doi: 10.1016/j.jhsa.2010.03.019.

23. Sorkin M, Cholok D, Levi B. Scar Management of the Burned Hand. Hand Clin. 2017;33(2):305-315. doi: 10.1016/j.hcl.2016.12.009.

24. Hop MJ, Langenberg LC, Hiddingh J, Stekelenburg CM, van der Wal MB, Hoogewerf CJ, et al. Reconstructive surgery after burns: a 10-year follow-up study. Burns. 2014;40(8):1544-51. doi: 10.1016/j.burns.2014.04.014.

25. Sari E, Tellioglu AT, Altuntas N, Seven E, Ozakpinar HR. Combination of rhomboid flap and double Z-plasty technique for reconstruction of palmar and dorsal web space burn contractures. Burns. 2015;41(2):408-12. doi: 10.1016/j.burns.2014.07.017.

26. Grishkevich VM. First web space post-burn contracture types: contracture elimination methods. Burns. 2011;37(2):338-47. doi: 10.1016/j.burns.2009.11.001.

27. Yotsuyanagi T, Yamashita K, Gonda A, Kato S, Sugai A, Yamada T, et al. Double combined Z-plasty for wide-scar contracture release. J Plast Reconstr Aesthet Surg. 2013;66(5):629-33. doi: 10.1016/j.bjps.2013.01.027.

28. Karanas YL, Buntic RF. Microsurgical reconstruction of the burned hand. Hand Clin. 2009;25(4):551-6. doi: 10.1016/j.hcl.2009.06.009.

29. Cole R, Shakespeare P, Rossi A. Conservative treatment of deep partial thickness hand burns--a long term audit of outcome. Br J Plast Surg. 1992;45(1):12-7. doi: 10.1016/0007-1226(92)90107-9.

30. Kalinova KI, Raycheva RD, Petrova N, Uchikov PA. Acute Management of Deep Facial Burns. Folia Med (Plovdiv). 2021;63(6):847-857. doi: 10.3897/folmed.63.e57073.

31. Fraulin FO, Illmayer SJ, Tredget EE. Assessment of cosmetic and functional results of conservative versus surgical management of facial burns. J Burn Care Rehabil. 1996;17(1):19-29. doi: 10.1097/00004630-199601000-00007.

32. Philp L, Umraw N, Cartotto R. Late outcomes after grafting of the severely burned face: a quality improvement initiative. J Burn Care Res. 2012;33(1):46-56. doi: 10.1097/BCR.0b013e318234d89f.

33. Still JM Jr, Law EJ, Belcher KE, Moses KC, Gleitsmann KY. Experience with burns of the eyes and lids in a regional burn unit. J Burn Care Rehabil. 1995;16(3 Pt 1):248-52. doi: 10.1097/00004630-199505000-00005.

34. Abu-Baker A, Țigăran AE, Peligrad T, Ion DE, Gheoca-Mutu DE, Avino A, et al. Exploring an Innovative Approach: Integrating Negative-Pressure Wound Therapy with Silver Nanoparticle Dressings in Skin Graft Procedures. J. Pers. Med. 2024;14:206. https://doi.org/10.3390/jpm14020206.

35. Echinard C, Dantzer E. La reconstruction du nez dans les brûlures pan-faciales profondes [Reconstruction of the nose in deep extensive facial burns]. Ann Chir Plast Esthet. 1995;40(3):238-50.

36. Rose EH. Aesthetic restoration of the severely disfigured face in burn victims: a comprehensive strategy. Plast Reconstr Surg. 1995;96(7):1573-85; discussion 1586-7.

37. Bouguila J, Ho Quoc C, Viard R, Brun A, Voulliaume D, Comparin JP, Foyatier JL. Nose burns: 4-dimensional analysis. Eur Ann Otorhinolaryngol Head Neck Dis. 2017;134(5):333-337. doi: 10.1016/j.anorl.2017.02.014.

38. Bichet JC, Chekaroua K, Alshreibati F, Jacquin F, Foyatier JL. Rhinoplastie dans la prise en charge immédiate des brûlures du nez. Note technique à propos de deux cas cliniques. Ann Chir Plast Esthet. 2002;47(6):641-646. doi:10.1016/S0294-1260(02)00156-5

39. Jouglard JP, Echinard C, Manelli JC, Palayret D. La chirurgie précoce des brûlés. Rev Prat 1980;30:555-563.

40. Foyatier JL, Voulliaume D, Brun A, Viard R, Dionyssopoulos A. Traitement chirurgical des séquelles de brûlures de la face [Face rehabilitation for post-burn deformities]. Ann Chir Plast Esthet. 2011;56(5):388-407. doi: 10.1016/j.anplas.2011.08.015.

41. Foyatier JL, Voulliaume D. Brûlures de la face et du cou au stade de séquelles. In: Traité de Chirurgie Plastique Reconstructrice et Esthétique. Elsevier Masson; 2010:273-291. doi:10.1016/B978-2-294-70151-1.50025-1

42. Williams FN, Herndon DN, Hawkins HK, Lee JO, Cox RA, Kulp GA, et al. The leading causes of death after burn injury in a single pediatric burn center. Crit Care. 2009;13(6):R183. doi: 10.1186/cc8170.

43. Cotte J, Prunet B, Esnault P, Lacroix G, D'aranda E, Cungi PJ, Goutorbe P, Dantzer E, Meaudre E. Early onset pneumonia in patients with severely burned face and neck: a 5-year retrospective study. Burns. 2013;39(5):892-6. doi: 10.1016/j.burns.2012.12.003.

44. Shenkman B, Stechmiller J. Patient and family perception of projected functioning after discharge from a burn unit. Heart Lung 1987; 16(5):490-6.

45. Avni J. The severe burns. Adv Psychosom Med. 1980;10:57-77. doi: 10.1159/000403292.

46. Patterson DR, Everett JJ, Bombardier CH, Questad KA, Lee VK, Marvin JA. Psychological effects of severe burn injuries. Psychol Bull. 1993;113(2):362-78. doi: 10.1037/0033-2909.113.2.362.

47. Rossi LA, Vila Vda S, Zago MM, Ferreira E. The stigma of burns. Perceptions of burned patients' relatives when facing discharge from hospital. Burns. 2005;31(1):37-44. doi: 10.1016/j.burns.2004.07.006.

48. Davidson TN, Bowden ML, Tholen D, James MH, Feller I. Social support and post-burn adjustment. Arch Phys Med Rehabil. 1981;62(6):274-8.

49. Clayton NA, Ledgard JP, Haertsch PA, Kennedy PJ, Maitz PK. Rehabilitation of speech and swallowing after burns reconstructive surgery of the lips and nose. J Burn Care Res. 2009;30(6):1039-45. doi: 10.1097/BCR.0b013e3181bfb907.

50. Iordache M, Bordeanu-Diaconescu E-M, Grosu-Bularda A, Andrei M-C, Frunza A, Grama S, et al. Our Experience and Clinical Findings in Perineal Burns: Implications for Patient Prognosis—A 3 Year Retrospective Study. Medicina. 2024; 60(12):2009. https://doi.org/10.3390/medicina60122009.

51. Tresh A, Baradaran N, Gaither TW, Fergus KB, Liaw A, Balakrishnan A, Hampson LA, Breyer BN. Genital burns in the United States: Disproportionate prevalence in the pediatric population. Burns. 2018;44(5):1366-1371. doi: 10.1016/j.burns.2018.02.023.

52. Giretzlehner M, Ganitzer I, Haller H. Technical and Medical Aspects of Burn Size Assessment and Documentation. Medicina (Kaunas). 2021;57(3):242. doi: 10.3390/medicina57030242.

53. Gillespie R, Carroll W, Dimick AR, Haith L, Heimbach D, Kibbee E, et al D. Diagnosis-related groupings (DRGs) and wound closure: roundtable discussion. J Burn Care Rehabil. 1987;8(3):199-209. doi: 10.1097/00004630-198705000-00005.

54. Harpole BG, Wibbenmeyer LA, Erickson BA. Genital burns in the national burn repository: incidence, etiology, and impact on morbidity and mortality. Urology. 2014;83(2):298-302. doi: 10.1016/j.urology.2013.10.039.

55. International Diabetes Federation. IDF Diabetes Atlas, 8th edition. Brussels, BE: IDF, 2017. Available at www.diabetesatlas.org/en/resources [Accessed 4 August 2025].

56. Diab J, Pye M, Parker C, O'Hara J, Maitz PK, Issler-Fisher AC. Management of foot burns with an emphasis on high-risk groups. Aust J Gen Pract. 2021;50(9):641-646. doi: 10.31128/AJGP-07-20-5508. .

57. Diab J, O'Hara J, Pye M, Parker C, Maitz PKM, Issler-Fisher A. Foot burns: A comparative analysis of diabetic and non-diabetic patients. Burns 2020;5:S0305-4179(20)30483-6. doi: 10.1016/j.burns.2020.07.024.

58. National Pressure Ulcer Advisory Panel, European Pressure Ulcer Advisory Panel and Pan Pacific Pressure Injury Alliance. Prevention and treatment of pressure ulcers: Clinical practice guideline. Osborne Park, WA: Cambridge Media, 2014. Search PubMed [Accessed 15 August 2025]

59. NSW Agency for Clinical Innovation. Statewide Burn Injury Service. Burn physiotherapy and occupational health guidelines. Chatswood, NSW: ACI, 2017. Available at www.aci.health.nsw.gov.au/__data/assets/pdf_file/0018/236151/Burns-PT-OT-Guidelines.pdf [Accessed 2 February 2025].

60. Mikhailov IA, Popov SV. Proceedings, International Conference on "Intensive Treatment of Severe Burn Patients", Moscow. 1992. Surgical treatment of the results of foot burns. pp. 284–6.

61. Shakirov BM. Evaluation of different surgical techniques used for correction of post-burn contracture of foot and ankle. Ann Burns Fire Disasters. 2010 Sep 30;23(3):137-43.

62. Shahrokhi S, Arno A, Jeschke MG. The use of dermal substitutes in burn surgery: acute phase. Wound Repair Regen. 2014 Jan-Feb;22(1):14-22. doi: 10.1111/wrr.12119. 63. Issa M, Badawi M, Bisheet G, Makram M, Elgadi A, Abdelaziz A, Noureldin K. Skin Graft Versus Local Flaps in Management of Post-burn Elbow Contracture. Cureus. 2021;13(12):e20768. doi: 10.7759/cureus.20768.

64. Iordache M, Grosu-Bularda A, Bordeanu-Diaconescu E.-M., Frunza A, Andrei M-C, Grama S, et al. Therapeutic management of burns affecting major joints of the limbs and the role of medical textiles in enhancing the rehabilitation process: 1 year retrospective study, In: Industria Textila, 2025, 76, 1, 131–143, http://doi.org/10.35530/IT.076.01.2023144.

65. Capek KD, Zapata-Sirvent R, Huang TT. Management of Contractural Deformities Involving the Shoulder (Axilla), Elbow, Hip, and Knee Joints in Burned Patients. Chapter in Herndon DN (editor), Total Burn Care (Fifth Edition), Elsevier 2018, Pages 573-588.e1

66. Huang TT, Blackwell SJ, Lewis SR. Ten years of experience in managing patients with burn contractures of axilla, elbow, wrist, and knee joints. Plast Reconstr Surg. 1978;61(1):70-6. doi: 10.1097/00006534-197801000-00012.

67. Gravvanis A, Kyriakopoulos A, Kateros K, Tsoutsos D. Flap reconstruction of the knee: A review of current concepts and a proposed algorithm. World J Orthop. 2014 Nov 18;5(5):603-13. doi: 10.5312/wjo.v5.i5.603.

68. Raborn LN, Janis JE. Prevention and Treatment of Burn Scar Contracture: A Practical Review. Plast Reconstr Surg Glob Open. 2024;12(1):e5333. doi: 10.1097/GOX.0000000000005333.

69. Goel A, Shrivastava P. Post-burn scars and scar contractures. Indian J Plast Surg. 2010;43(Suppl):S63-71. doi: 10.4103/0970-0358.70724.