Management of Post Burn Hand Contractures in Yemen

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Abstract:

• Background: Burn contracture of the hand can result in significant impairment of both physical and mental well-being in patients. Various procedures are being used to reconstruct hand contractures resulting from burns, with the goal of creating a sufficient web space and separating fused digits to achieve both aesthetic and functional improvement in a timely manner.

• Patients and Methods: This study utilized a prospective descriptive case methodology. A study was undertaken on a sample of 60 patients to evaluate the functional outcomes of several reconstructive methods for post-burn contractures of the hand. The aim was to determine the most effective surgical intervention for recovering hand capabilities required for daily activities.

• Results: The results of our study indicate that the majority of participants were female (63.26%) and male (36.74%), with the majority falling into the middle-

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aged range of 19–50 years. The median age was 19 years old. Approximately 85.17% of participants were right-handed. The reconstruction procedures used included STSG, FTSG, and Z-plasty. Early complications included infection (3.3%), graft loss (3.3%) which required reoperated, and tip flap necrosis (1.7%) which managed by dressing and secondary intention. Late complications were also observed. There was a recurrence of contracture in 8.4% of cases and hypertrophic scar formation in 5% of cases. The reconstruction was performed using a cross-finger flap.

•Conclusions: post-burn hand contracture can be effectively managed with Z-plasty and its modifications and skin grafts. Postoperative routines include physiotherapy, splinting, and flap selection based on contracture size, location and donor tissue availability. The surgeon experience is also crucial for optimal results.

Key Words: Burns, Hand Contracture, Flexion, Proximal Interphalangeal (PIP), Z-plasty, Split-Thickness Skin Graft (STSG), Full-Thickness Skin Graft (FTSG), Cross Finger Flap.

Introduction:

The hand is an intricately specialized appendage comprised of numerous delicate components. Any alteration in the structure of the hand leads to a functional deformity, which hinders daily activities.)1(Additionally, as the primary means of interaction between humans and their surroundings, it plays a vital role in perception and expression. (2) However, it is also extremely prone to burn damage. (3) The burns can be induced by various sources.The primary origins of burns are thermal (such as fire, scalds, and hot items), electrical, and chemical agents. .(4) Burns are the second most common cause of death related to trauma globally and the primary cause of hand contractures that restrict daily activities. Yemen's status as a developing nation is characterized by high levels of poverty, illiteracy, and ongoing wars and conflicts. The bulk of burn incidents in Yemen are attributed to the negligent use of domestic gas, cooking over open fires, and improper handling of benzene. These incidents are particularly prevalent in low-income areas.In children, particularly infants, the most prevalent causes of burns are accidentally rolling into unguarded fires, scalding burns, exposure to home electrical currents, and explosions caused by poorly constructed stoves. Common causes of burns in adults, especially females as indicated earlier, include kitchen burns resulting from gas leaks or explosions, as well as electrical burns, which are more common in males. These occurrences can lead to severe burns that result in disfigurement and impairment. Even if the hands make up less than 5% of the total body surface area, it is important to recognize that any burns in this region are considered severe and meet the criteria for referral to a burn center, as stated by the American Burn Association (ABA) and American College of Surgeons (ACS) (5). Deep thermal burns to the handcan lead to severe hand contractures and significant functional restrictions as the final outcome.(6) Post-burn hand deformities are diverse and can manifest in atypical manners. One of the most frequent consequences of hand burn injury

is the development of flexion contractures in the proximal interphalangeal (PIP) joints. Furthermore, it is characterized by the coexistence of flexion contracture in one joint and extension contracture in a neighboring joint (7). The outcome of the burns deformity has a considerable impact on patients' lives, often resulting in job loss or the need to shift occupations. This is mostly due to the absence of specialized burn hospitals in most places outside the capital. Additionally, a significant number of patients may arrive late for their appointments or opt for inappropriate procedures, such as relying on traditional medicine or inadequate physiotherapy, due to their financial circumstances. The therapy of post-burn handabnormalities is typically multifaceted, affecting both the patient and the healthcare system. It is often a protracted and complex process. Given the aforementioned reasons, we have chosen to examine and assess several surgical techniques for repairing handdeformities caused by burns. Our focus will be on evaluating the functional and aesthetic results of these surgeries.

Material and methods:

Under an active institutional review board-approved protocol, this prospective case series study was conducted by a team of plastic surgeons at three hospitals (the Yemeni Germany hospital, Cure hospital, and Algamhori hospital) over a period from 2019 to 2023. A total of 60 patients with hand contractures underwent a variety of surgical procedures, according to patient condition and preference. Data were collected, and the male-to-female ratio was 2:3. A short history including the patient's demographics, duration and mechanism of burn, hand dominance, type of post-burn contracture, unilateral or bilateral, which hand was involved, severity of contractures and their effects on limitation of hand function, and associated hand deformities were recorded. Clinical examination, including types of post-burn contracture, the side and the involved hand, and severity of the post-burn flexion contracture deformity, Also, range of motion, which was classified according to McCauley into four severity grades,

and associated injuries were documented. Surgical details, including flap design, dimensions, and preoperative antibiotic, are given. intraoperative findings, complications, and follow-up period. In all cases, preoperative and postoperative photographs were recorded. Exclusion criteria were adapted, such as Grade I, II,II and immature hypertrophic scars. All patients are assessed clinically for the viability of the flaps, skin graft take, and any early complications such as wound breakdown, flap necrosis (partial or complete), and skin graft loss. Patients are followed up weekly for two weeks, twice weekly for one month, and monthly thereafter for six months, looking for late complications such as hypertrophic scars, keloid, and recurrence of contracture. Furthermore, surgeon/patient satisfaction was assessed using a modified scoring system created in collaboration with experts in the field of hand surgery. The scoring system consisted of three questions assessing overall satisfaction with the appearance, function, and pain or discomfort of the treated hand. Each question was scored on a scale of 0–10, with 0 indicating complete dissatisfaction and 10 indicating complete satisfaction. The mean satisfaction score for the entire cohort was calculated. Satisfaction scores were collected from all adult patients in the cohort as well as from parents of children aged 12 years or younger. We collected satisfaction scores at the final follow-up. Functional outcome is also rated as good if there is improvement greater than 75% of the normal range for that joint. It is graded poor if improvement is less than 50% of the normal range. In between these two are graded average recovery. Physiotherapy is started as soon as possible. Scar control measures such as pressure garments, silicon sheets, and ointments were started after three weeks, once the healing of the graft or flap was ensured. The treatment of post-burn hand contractures involved a multi-disciplinary approach that includes splinting, hand therapy, and surgery. Static and dynamic splinting methods help to preserve the range of motion while inhibiting the development of additional contractures. Hand treatment entails creating and executing customized exercise regimens aimed at improving the

affected hand's flexibility, strength, and coordination. In severe cases where traditional methods are insufficient, surgical intervention, such as operations to remove scar tissue, becomes necessary. Postburn hand contracture therapy utilizes a range of surgical methods, each possessing distinct benefits and drawbacks. Several approaches to skin grafting include split-thickness grafts that include both the epidermis and sections of the dermis, full-thickness grafts, local flaps, regional flaps, and constant flaps. Local flaps provide dependable results with a complete range of movement, outstanding cosmetic effects, and low recurrence rates. However, they may not cover deficiencies, which can cause partial flap loss and infections. Regional flaps, such as radial artery perforator flap, provide excellent color, texture matching, and shape. However, they also have the disadvantage of increasing the likelihood of venous congestion and bulkiness in the anterior region of the flap. Utilizing distant flaps can decrease the likelihood of hand stiffness, while postponing hand therapy after childbirth can result in postpartum stiffness. Free flaps provide enhanced functional and aesthetic results at the recipient site and enable a one-step reconstruction, eliminating the necessity for several treatments. Nevertheless, badly burned patients may have difficulties as a result of changed hemodynamic conditions, which could result in an increased rate of complications .

Statistical analysis

The data were entered in an MS Excel spreadsheet and analyzed using SPSS version 26. Descriptive statistics were employed to summarize the patient demographics, intraoperative details, and postoperative outcomes. p-value less than 0.05 was considered statistically significant

Results

The sample of the current study is 60 patients with post burn hand contracture. Female patients are 63.26% and male patients are 36.74% who most of them

are middle aged 19-50 with median age 19 years and proximately 85% are right handed, and half of them classified as Grade IIIA with flexion contraction (46.7%,N=28) and rest contribute to GIIIB,C,GIVA,B, C equally (10% N=6 for each). According to the aforementioned McCauley's severity grade, most common site for contracture is volar surface of fingers (60%, N=36), despite palmar suffice least affected (6.7% ,N=4) ,FTSG is most producer employed (46.71%, N=28) ,fallowed by STSG (23.35%N=14), Z-plasty (13.4% N=8), rest with locoregional flaps (15%,N=10). Crossed finger flap is used for sever recurrent contractures, postoperative fixation is performed either by k-wire or by external fixation ,or splint in (70%,N= 42) , postoperative fallow-up ensure , with early complication in first 2weeks is observed only (8.3% ,N= 5) of patients , begin with infection of graft (3.3%N=2) which manage by dressing and antibiotics , followed by graft loss mainly in STSG (3.3 %, N=2) which required reoperated and tip flap necrosis (1.7%,N=1) managed by dressing and secondary intention. late complications that presented after 4 month, they include recurrent contracture in (8.4% ,N=5) and hypertrophic scar in(5% ,N=3) and all of them reconstructed with cross finger flap , with good recovery.

Table (l): classification of burn contractures based on McCauley's severity grade.

McCauley's grade	No. of Hands	Percentage %
Grade III A	28	46.7
Grade III B	6	10
Grade III C	8	13.3
Grade IV A	6	10
Grade IV B	6	10
Grade IV C	6	10
Total	60	100

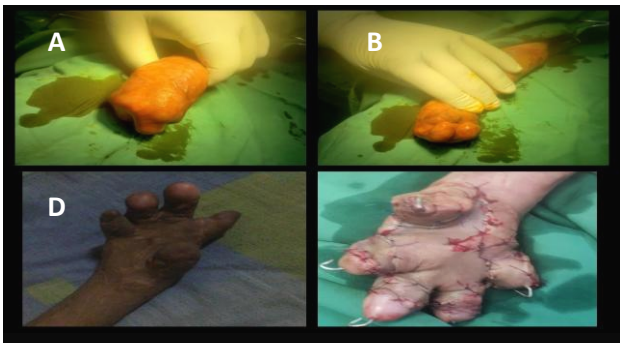
Table (II): classification of post burn hand contractures according to the site of contracture. Type III, IV

Site of contracture	No. of Cases	Percentage %
Volar surface of index, middle, ring and little fingers	36	60
Volar surface of thumb	6	10
Dorsal surface of thumb	2	3.3
Dorsum of Hand	4	6.7
Palm surface of hand	4	6.7
Volar surface of the wrist	2	3.3
Dorsum surface of the wrist	6	10
Total	60	100

A) Post- burn contracture of dorsal of both hands

Surgical procedure	Number of procedures	precent
STSG	14	23.28%
FTSG	28	46.76%
Z-plasties	8	13.36%
Local transposition flap	6	10%
Abdominal flap	2	3.3%
Groin flap	2	3.3%
Total	60	100%

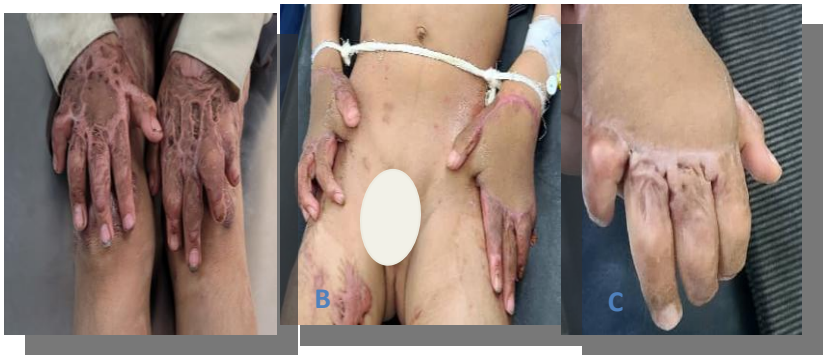
Some operated cases



A, B) post burn right hand e sever contracture
C) Release contracture with FTSG and k-wire
D) 6 month post operative

A) post-burn scar contracture of dorsal hand and fingers.

B) After contracture release and coverage by STSG with K-wires fixation.



B) Release contracture by groin flap of both hand

C) separation of flap of both hand

A, B) Post- burn contracture of volar of thumb. middle, ring
C, D) Release contracture and cross finger flap and FTSG for donor site
E) post separation

A) recurrent contracture post STSG

B) Reoperation with cross finger flap

C)post separation

Discussion:

The hand comprises less than 5% of the total surface area of the body (3). However, the loss of a hand results in a significant decrease of 57% in overall functionality for an individual (8, 9). Regardless of whether the burned hand is a standalone injury or part of a larger burn affecting the entire body surface area, the most troubling long-term effects of burn damage are the formation of scars and contractures that hinder normal functioning. These burn injuries are characterized by taut and abbreviated scar tissue. They can develop around joints, which can restrict movement or lead to deformity as a result of their interaction with a movable anatomical part. Plastic surgeons frequently encounter patients with finger burn abnormalities. Management of such malformations necessitates a longer duration, involves intricate surgical techniques, and remains a formidable task in the field of plastic surgery. (10) Contracture release is necessary not only for practical improvement but also for aesthetic purposes. (11) Therefore, we conducted the current study to evaluate the efficacy of different surgical methods used to correct abnormalities. Our study included 60 patients who underwent various techniques to repair post-burn hand contractures. We observed that the majority of these patients were middle-aged females (63.26%; N = 38) who spent a significant amount of time in the kitchen preparing food. In contrast, males (36.74%; N = 22) had a median age of

19 years. The majority of them, specifically 85% (N = 51), are right-handed, whereas the remaining 15% are left-handed. Typically, contractures or scarring in the dominant hand negatively impact the patient's vocation and financial circumstances. Choosing the correct approach and time for surgery, along with closely monitored rehabilitation, can greatly improve the chances of survival for someone who has suffered from burns. The results indicate a divergence when compared to the Suneel Kumar et al, research in 2020 (12), which examined 93 patients with hand abnormalities resulting from burns. The average age of the his patients was 27.36 years, with the largest proportion of patients being within the 31–45 age group (34.4%). The number of male patients was 62, accounting for 66.7% of the total, while the number of female patients was 31, making up 33.3%. Out of the total number of patients, 79 (84.9%) were right-hand dominant, whereas 14 (15.1%) were left-hand dominant. And categorized the patients based on their jobs, including students (n = 24, 25.8%), laborers (n = 47, 50.5%), housewives (n = 13, 14%), and others (n = 9, 9.7%). All patients received surgical intervention. (12) The palmar surface of the hand is the most commonly affected by contracture in children and volar surface is commonly on adults. Contrary to the findings of the Nagaraj study in 2021, which reported that palmar involvement is the least common due to its strong ability to recover, the prevalence of contracture is highest among female homemakers and cooks. To protect the flexor tendons and digital neurovascular bundles even more, the palmar fascia and fibrous septae are present. Deep palmar burns have a slower epithelialization process compared to superficial burns, but they result in fewer instances of scarring and contractures. (13) We conducted a comprehensive assessment of the deformity in the skin, tendons, joints, and bones during the formulation of the treatment plan to determine the operating strategy. Selecting surgical treatments that will offer the patient the greatest advantage during each operation when a hand's range of motion is significantly limited. Kucan and Bash emphasize the need to adhere to the well-defined reconstructive ladder,

selecting the most straightforward approach that will successfully accomplish the desired reconstructive objectives (14). The predominant reconstructive techniques utilized are FTSG (46.71%, N = 28), followed by STSG (23.35%), Z-plasty (13.36%), local transposition flap (6.7% and 3.3%), radial forearm flap, abdominal flap, and groin flap. 38.23% of cases employ postoperative fixation, 20.02% use k wire or external fixation, 11.69% use splints, and the remaining patients 30.06% proceed without any form of fixation. We can divide postoperative complications into two categories: early complications within the first two weeks and later complications. In the early phase, the majority of patients (91.7%, N = 55) did not experience any complications after the procedure. Only a small percentage (3.3%, N = 2) developed an infection in the graft, which was successfully treated with repetitive dressing and antibiotics. Additionally, there were two cases (3.3% N = 2) of graft loss with dehiscence, primarily in the STSG, which required reoperation using FTSG. The third type of complication was tip flap necrosis with Z-plasty, occurring in 1.7% of cases (N = 1). This was managed through daily dressing and secondary intentions. Delayed problems occurring after 4 months include hypertrophic scar (3 cases, 5% prevalence), recurrence of contracture with limited functionality, and severe flexion contracture (5 cases, 8.3% prevalence). A cross-finger flap procedure can effectively treat these complications. In general, the flap survival rate was outstanding, with around 89.35% (N = 55) of patients achieving complete flap survival. The median duration of hospitalization was 2 days, particularly for patients who underwent k-wire fixation to monitor finger color, temperature, and capillary refilling. STSG, FTSG, , Z-plasty , locoregional flaps are preformed. The findings appear to contradict the results of the Abdulmalik Alsaif et al. study (2022), which indicate that split-thickness skin transplants offer benefits in terms of scar, cosmetic, and color evaluations and show less hair development compared to full-thickness skin grafts. Particularly in pediatric patients. (15) In their study, Basta et al. (2020) highlight the significant benefits

of using the cross-finger flap technique. This method effectively maintains the length, shape, and sensory and functional capabilities of the affected digit. In conclusion, when treating post-burn hand deformities surgically, Z-plasties and their modifications are the most effective in achieving both functional and aesthetic improvements, if applicable. (16) If not, we can use skin grafts to cover most of the flaws. Undoubtedly, a rigorous postoperative routine of physiotherapy and splinting is essential for achieving the best possible result. For patients who need flaps, it is crucial to carefully choose the appropriate flap based on the size and location of the defect, the availability of donor tissue, and the surgeon's skill level. These factors are essential for achieving the best possible result.

Conclusion

post-burn hand contracture can be effectively managed with Z-plasty and its modifications, skin grafts. Locoregional flap preferred to be of choice for sever contracture. Mainly we recommend using cross finger flap for sever recurrent contracture. Postoperative routines include physiotherapy and splinting, and flap selection based on contracture size, location, donor tissue availability, and surgeon experience is crucial for optimal results.

Conflicts of Interest:

The authors declare no conflicts of interest related to this study.

References

.1 Hariharan N, Sridhar R, Sankari B, Valarmathy V, Asirvatham E, Geetha K. Reconstruction of postburn crippled hands: A study of functional outcome. Indian J Burns. 2018;26(1):9

.2 Robson M.C., Smith D.J., Vander Zee A.J. etal. : Making the burned handfunctional. Clinics in Plast. Surg., 1992,19:663

.3 Kurtz man LC, Stern PJ. Upper extremity burn contractures. Hand clinics., 1990;6:261-79

.4 Grishkevich V, Grishkevich M. Postburn Scar Contractures: Formation, Anatomy and Classification. Adv Pla¬¬¬¬st Reconstr Surg. 2016;1(1):18–24

.5 Nelson D.L.: The importance of the physical examination. Hand Clinton., 1997-135:13.

.6 Fufa DT, Chuang ss, Yang JY. Post burn contractures of the hand. Journal of Hand Surgery. 2014;39 (9):1869-76.

.7 Gkalanl., Zgürf., Gürsu G., kecik A,: factors affecting results in thermal hand burns. Annals of Burns and Fire disasters 1996,9:222-8.

.8 American Medïcal Association: Guides to the evaluation of permanent impairment, 4th ed. Chicago: American Medical Association, 1994.

.9 Engrav LH, Dutcher KA, Nakamura DY. Rating burn impairment. Clin plast surg. 1992;19:569-98.

.10 Ali H, Zulfiqar B. Reverse radial forearm flap; management of soft tissue defects of dorsum of hand and wrist using reverse radial forearm flap. Prof Med J. 2018;25:12.

.11 Saaiq M, Zaib S, Ahmad S. The menace of post-burn contractures :a developing country's perspective. Ann Burns Fire Disasters. 2012;25(3):152–158. [PMC free article] [PubMed] [Google Scholar[

.12 Sunil N, Ahmed F, Jash P, Gupta M, Suba S. Study on Surgical Management of Post Burn Hand Deformities. J Clin Diagn Res. 2015;9(8):6–10

.13 Gareikpatii N. Study of soft tissue reconstruction in postburn flexion contracture of the hand. Int Surg J 2021;8:3259-63

.14 Kucan JO, Bash D. Reconstruction of the burned foot. Clin Plast Surg. 1992; 19: 705 - 19.

.15 Abdulmalik Alsaifa,1 , Mohammad Karamb,□,1 , Amrit Hayrec , Ahmad Abuld , Ahmed Aldubaikhie , Narvair Kahlar, Full thickness skin graft versus split thickness skin graft in paediatric patients with hand burns: Systematic review and meta-analysis, https://doi.org/10.1016/j.burns.2022.09.010 0305-4179

.16 Bista N, Shrestha KM, Bhattachan CL , Cross finger flap for reconstruction of complex finger defects, Nepal Med Coll J 2015; 17(1-2): 73-7