Postburn Hand Deformities: Principles of Management and Approach

Kunal Mokhale, Mohd. Fahud Khurram, Imran Ahmad, *Pankaj Singh, Girish Sharma, Tushar Patil
Department of Plastic and Reconstructive Surgery, Jawaharlal Nehru Medical College,
Aligarh Muslim University, Aligarh, Uttar Pradesh, India.

***Correspondence:** pankajkgmc07@gmail.com

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ABSTRACT
The hand is one of the top 3 locations for burn scar contracture deformity. The functionality of the hands is one of the primary determinants of burns survivors' quality of life. Although most burn abnormalities are preventable, they do arise when adequate treatment is not delivered in an emergency or when they are part of a major burn. Reconstructive surgeries can significantly improve hand function. For a burn's survivor, the right methods and timing of surgery, followed by supervised physiotherapy, can be a game changer.

KEYWORDS: Contracture Release; Hand Burns; Postburn Hand Deformity.

1. INTRODUCTION

The functionality of the hands is one of the primary determinants of burns survivors' quality of life. If bilateral, postburn hand deformities can render a burn victim completely pauperized (Figure 1). Good initial care such as elevation of the hand, adequate splinting, early grafting of severe burns, and supervised physiotherapy can help to prevent the problem. Tredget discovered that 54% of patients with a 15% total body surface area burn sustained burns to the hand and upper extremity [1]. Because hand burns are so common, the odds of developing a deformity are significant. One of the 3 most common sites of burn scar contracture deformities is the hand [2].

Figure 1: Severe burn contracture of bilateral hand.

McCauley has categorized burn scar contractures (Table 1) [3]. To offer a patient with the optimum functional outcome, the right procedures must be chosen.

Table 1: Classification of burn scar contracture.

Grade I	Symptomatic tightness but no limitations in range of motion, normal architecture
Grade II	Mild decrease in range of motion without significant impact on activities of daily living, no distortion of normal architecture
Grade III	Functional deficit noted, with early changes in normal architecture of the hand
Grade IV	Loss of hand function with significant distortion of normal architecture of the hand
Subset classification for Grade III and Grade IV contractures: A: Flexion contractures, B: Extension contractures, C: Combination of flexion and extension contractures	

In this study, we observed the outcome of the different modalities of the postburn contracture.

2. METHOD(S)

This single-center observational study was conducted from December 2018 to December 2019. Forty patients with postburn hand deformities hospitalized in Department of Plastic and Reconstructive Surgery, Jawaharlal Nehru Medical College, Aligarh Muslim University, Aligarh, Uttar Pradesh were included in the study. The participants ranged in age from 4 to 45 years old with an average age of 24.5 years. There were 18 females and 22 males in this study. Skin contractures in the form of dorsal contractures, volar contractures, web syndactyly, and other postburn hand abnormalities were presented. Patient's consent was taken for surgery and for publication of photographs in the study.

2.1. PATIENT EVALUATION

The accident's full history, type, primary burn management, and duration were all part of the patient's evaluation:

1. The patient was asked to define the impairment caused by the deformity during the evaluation of hand functions.
2. A local examination of the hand is performed, which includes:
   a. The look of the hand and its resting position
   b. Direct observation of hand activities
   c. Skin examination
   d. Joint movement
   e. Tendon examination
   f. Vascular examination
   g. Clinical nerve examination

2.2. INVESTIGATIONS

The investigations were carried out in light of the severity of the patients' condition and the surgical treatments carried out (plain X-ray, MRI, Doppler ultrasound).

2.3. SURGICAL PROCEDURES

All patients underwent a variety of surgical procedures specific to the management of individual postburn hand deformity (Table 2).

Table 2: The various surgical modalities.

Dorsal contracture (14 patients)	7 patients covered with split-thickness skin graft
	3 patients covered with distally based radial forearm flap
	4 patients covered with pedicle groin flap
Volar contracture (10 patients)	6 patients underwent release and split-thickness graft
	4 patients treated with multiple V-Y plasty
First web space reconstruction (3 patients)	2 patients treated with multiple 5-flap plasty
	1 patient treated with distally based radial forearm flap
Syndactyly of fingers (2 patients)	Treated with release and multiple V-Y flap and split-thickness graft
Wrist reconstruction (3 patients)	1 patient underwent release and was covered with V-Y plasty
	1 patient underwent release and split-thickness graft and splint
	1 patient underwent release and groin pedicle flap

Tendon reconstruction (2 patients)	1 patient underwent tenolysis
	1 patient underwent tendon transfer
Complex deformities (6 patients)	2 patients treated with release, tenolysis, capsulotomy, and skin graft.
	1 patient treated with release and cross-finger flap
	1 patient treated with release, tenolysis, capsulotomy, and direct closure
	2 patients treated with release, capsulotomy, and distally based first dorsal intermetacarpal flap

Figure 2: Volar contracture of left little finger: z plasty done.

Figure 3: Volar contracture of left middle finger, ring finger and thumb: z plasty, release, and grafting done.

2.4. POSTOPERATIVE CARE

All patients received the following*:*

1. Broad-spectrum antibiotic depending on body weight for 7 days postoperatively.
2. A strong anti-inflammatory for 5 days postoperatively.
3. Elevation of the hand to prevent postoperative, edema, and alleviate pain.
4. A postoperative hand splint was constructed in routine manner.
5. A physiotherapy program was planned for each case, depending on the surgical procedure.

Follow up: The follow-up period ranged between 6 and 12 months.

3.RESULTS

An examination of the patients reveals a predominance of males over females in terms of gender, while the majority of the patients were under 30 years old in terms of age. The majority of the injuries were caused by fire. Skin contractures (dorsal contractures, volar contractures, syndactyly, etc.) were found, with predominance of dorsal contractures (46.33%). When it came to contractures, little finger contractures were the most common (70%).

In 8 cases, both hands were affected, 15 cases involved only the right hand, and 17 cases involved only the left hand. Results and functional gain of each procedure are summarized in following Tables 3–13.

3.1. DORSAL CONTRACTURES

Table 3: Results of reconstruction in dorsal contractures.

Number of cases	Reconstruction	Results	Secondary procedures
9 (16 hands)	Split-thickness skin graft	Take 98%	Flexion contracture of little finger
2	Distally based radial forearm flap	Complete survival	-
2	Island groin flap	Complete survival	-
1	Pedicled groin flap	Complete survival	-

Table 4: Functional gain after dorsal contracture reconstruction.

Preoperative position of deformity		Postoperative gain	
Within normal range of motion 10 patients	Outside normal range of motion 4 patients	Limited range of motion 2 patients	Full range of motion 12 patients

3.2. VOLAR CONTRACTURES

Table 5: Results of reconstruction of volar contractures.

Number of cases	Reconstruction	Results
7 fingers	Contracture release and split thickness skin grafting	Local flaps completely survived and complete take of split-thickness graft
9 fingers	Release and split thickness Graft 5 full thickness 4 prepuce skins	Complete take
8 fingers	Multiple Y-V plasty	Local flap completely survived

Table 6: Functional gain after volar contracture reconstruction.

Preoperative position of deformity	Limited range of motion	Full range of motion
All cases of flexions within normal range of movement		24 patients

3.3. SYNDACTYLY

Table 7: Results of reconstruction of syndactyly.

Number of cases	Reconstruction	Results
6 web spaces	Three square flaps and split-thickness graft	Complete survival of flaps and 100% graft take
4 web spaces	V-M plasty	Complete survival of flap.

3.4. FIRST WEB CONTRACTURES

Table 8: Results of reconstruction of first web contractures.

Number of cases	Reconstruction	Results
2	5-flap plasty	Complete survival
1	Distally based radial forearm flap	Complete survival

3.5. WRIST DEFORMITIES

Table 9: Results of reconstruction of wrist deformities.

Number of cases	Reconstruction	Results
1 case (2 hands)	Multiple Y-V plasty	Complete survival
1	Split-thickness skin graft	100% take
1	Pedicle groin flap	Complete survival

Table 10: Functional gain after wrist reconstruction.

Preoperative position of deformity	Limited range of motion	Full range of motion
Abduction (2 hands)	–	Full
Abduction	–	Full
Flexion	Further reconstruction needed for tendons and nerve	

3.6. TENDON DEFORMITIES

Table 11: Results of reconstruction of tendon deformities.

Number of cases	Reconstruction	Results
1	Tendon transfer	Good opponens
1	Tendon graft	100% take

3.7. COMPLEX DEFORMITIES

Table 12: Results of reconstruction for complex deformities.

Number of cases	Reconstruction	Results
3 cases (8 fingers)	X-release, tenolysis, capsulotomy, and skin graft	Complete survival and take
1 case	Release and cross-finger flap	Complete survival of flap
1 case (1 thumb)	X-release, tenolysis, capsulotomy, and distally based first dorsal intermetacarpal flap	Partial superficial desquamation of flap (Conservative healing)
1 case (4 fingers)	Tenolysis, capsulotomy, and direct closure of grafted skin	Complete survival and take

Table 13: Functional gain after reconstruction of complex deformities.

Preoperative position of deformity	Limited range of motion	Full range of motion
Flexion in 5 cases within normal range of motion (10 fingers)	4	1
Extension in 1 case outside normal range of motion (4 fingers)	2 fingers (little finger and ring finger)	2 fingers (middle finger and index finger)

4. DISCUSSION

The complexity of postburn deformity stems from the fact that various structures, including skin contracture, joint stiffness, and tendon adhesions, may all contribute to the deformity. Hence, the importance of a deformed hand cannot be overstated.

Unfortunately, this is a challenging process, and the surgeon is frequently required to do additional tests or wait for the intraoperative results [4]. There are some general principles for the treatment of postburn hand deformity [5].

1. The burn surgeon must focus on restoring function rather than just expanding the range of motion of specific joints while reconstructing a deformed hand.
2. Choose the first set of procedures that will provide the most benefit to the patient when a hand is significantly involved.
3. Although function is critical, a burn surgeon must also consider the esthetic component of a burned hand reconstruction.
4. For appropriate treatment strategy, evaluate the abnormality in each tissue component.
5. Excision of scar tissue and correction of deforming forces are more important than the sort of skin cover used to repair the deformity.
6. The timing of surgery is critical for a successful deformity repair. It is preferable to do surgery when tissue equilibrium has been achieved, as evidenced by a decrease in induration and the appearance of pale scars.
7. To obtain a positive outcome, physiotherapy, splinting, and scar management are necessary.

A thick split-thickness skin graft was employed as coverage in this study for dorsal contracture, providing outstanding results in the patients. Our results are consistent with previous reports [6]. Prolonged periods of postoperative physiotherapy, splinting, and pressure garments were required to maximize the esthetic and functional outcome.

A radial forearm flap was employed as coverage in 2 cases, and the outcome was satisfactory. The radial forearm flap has a lot of benefits, which is why it has such a good reputation. It has a robust arterial inflow through a retrograde flow into the radial artery, and good venous drainage through the venae comitantes of the radial artery. It yields skin that is thin, pliable, and hairless plus a large skin territory to be included in the flap. Our findings were in line with those found in the literature [7, 8].

Groin flaps were employed to cover soft tissue in 3 situations. For a long time, the groin flap has been the primary method of covering hand deformities. Long flaps can be constructed that extend well beyond the zone served by the well-known artery. There have been no difficulties with these flaps, and good results have been attained. The disadvantages of this flap are its thickness and the need for prolonged immobilization till separation. Our findings were similar to those of Koshima [8].

We found that when the positions of the abnormalities of the metacarpophalangeal joints were within the normal range of motion, good functional results were obtained; however, when the positions of the deformities of these joints were outside the normal range, there was less functional gain.

Several options for covering these palmar finger deformities have proven to be reliable in the release of volar contracture. To optimize the effect of employing local tissue release, contracture release is conducted across the line of contracture and the margins are sutured, bringing soft tissues from the lateral sides and a skin graft [9]. The Y-V advancement procedure, which combines V-advancement and z-plasty, promotes the release of linear flexion contractures in the fingers, especially the thumbs [10].

The findings of this study were in line with previous reports on the treatment of palmar contractures using skin grafts and local flaps [11]. Although it is claimed that split-thickness skin grafts have fewer inclinations toward hyperpigmentation, resulting in superior results in view of cosmesis, we also agree that there is no substantial difference between split-thickness and full-thickness skin grafts [12].

In postburn syndactyly, surgery aims to achieve 1 of 3 goals: breaking the line and lengthening a straight-line contracture, re-creating the web space commissure using a local flap, and adding skin from outside the local area for severely damaged web spaces. Depending on the availability of unscarred skin, many local flaps were utilized to treat syndactyly [13]. Methods such as z-plasty, V-M plasty, square flap, 5-flap release, and a dorsal flap with lateral digital extensions are all beneficial [14-16]. In our study, the outcomes were outstanding, demonstrating the long-term viability and reliability of utilizing local flaps in web contractures. This is in line with the findings of Lapid and Sagi [17].

4.1. FIRST WEB ADDUCTION CONTRACTURES (3 CASES)

Two patients were treated with skin release, partial release of the adductor pollicis and first dorsal interossei, and reconstructed in the z-plasty with 5 flaps in 1 patient radial forearm flap was used. The outcomes were satisfactory and in line with findings of Safak and Tecik [18, 19].

4.2. WRIST DEFORMITIES (3 CASES)

Multiple Y-V plasty extending from the dorsum of the thumb to the elbow, complete excision of the scar tissues, the resultant defect being covered with a skin graft, the contractures were released, and the defects were covered by groin flaps, for further reconstruction of the flexor tendons and median nerve in the wrist. In every case, satisfactory outcomes were obtained.

4.3. SKIN AND TENDON DEFORMITIES (2 CASES)

The first of these 2 cases consisted of loss of the extensor of the left thumb, which was managed by tendon transfer from the flexor digitorum superficialis of the ring finger for opponoplasty. The second case (postburn loss of the medial 3 extensor tendons

on the dorsum of the left hand) was managed with tendon grafts. All of the tendon reconstruction patients studied in this study yielded excellent results.

4.4. COMPLEX DEFORMITIES (6 CASES)

Release of the skin contractures, tenolysis, and capsulotomy with partial release of the collateral ligaments was used to treat all 6 patients (skin, tendon, and joint abnormalities). In every case, satisfactory outcomes were obtained. Our results in the management of complex deformities were consistent with those of Graham *et al*. [20].

5. CONCLUSION

Surgery is still the gold standard for treating grade III and grade IV contractures, which can appear with a range of abnormalities. The goal of treatment is to return the patient to a state of near-normal function. There are a multitude of surgical procedures available, with surgeons demonstrating and reporting their own with varying degrees of effectiveness. In order to regain optimal function, an intense rehabilitation program should be started immediately following the operation.

PRESENTATION

Not presented in any seminar/conference.

AUTHOR CONTRIBUTIONS

All cases were done under the supervision of Professor Imran Ahmad and Associate Professor Dr. MF Khurram. All authors contributed equally in the study.

CONFLICT OF INTEREST

None.

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