

# Clinical Evaluation and Management of Post Burn Flexion Contractures of Fingers: A Prospective Observational Study

GB KARTHIK<sup>1</sup>, KC SHIVAMURTHY<sup>2</sup>, SUHAS NARAYANASWAMY GOWDA<sup>3</sup>, KOSURI DEEPAK VARMA<sup>4</sup>

## ABSTRACT

**Introduction:** The management of post burn sequelae of the hand, such as contractures and deformities, is of particular significance in developing countries due to delayed presentations and non compliance with treatment.

**Aim:** To assess the appropriate choice of reconstruction for post burn flexion contractures of the fingers and its functional outcome.

**Materials and Methods:** This prospective observational study included 45 patients with post burn flexion contractures of the fingers over a duration of three years, from March 2021 to February 2024, in the Department of Plastic and Reconstructive Surgery at SSIMS & RC, Davangere, Karnataka, India. Patients were evaluated for age, etiology of burns, duration since the burns, grade of contracture, choice of reconstructive procedure, and functional outcome in terms of the degree of extension achieved. Descriptive statistics were used, and results were expressed in terms of frequency and percentages.

**Results:** Out of total patients, 16 (35.5%) patients belonged to the age group of 1-10 years, and 14 (31.1%) patients were aged

11-20 years. Flame burns accounted for 24 (53.3%) patients. Thirty-six (80%) patients had grade III contractures. Fifteen (33.3%) patients were operated on between six and 12 months post burn, while 19 (42.2%) patients were operated on more than 24 months post burn. A total of 28 (62.2%) patients were affected on their dominant hand, restricting their activities of daily living. Contracture release and Split-Thickness Skin Grafting (STSG) were performed in 18 (40%) patients, while release and Full-Thickness Skin Grafting (FTSG) were performed in 14 (31.1%) patients. Functional improvement in the form of full extension of the fingers was achieved after contracture release in 44 (97.8%) patients. In 1 (2.2%) patient, residual flexion of 10 degrees was noted at the distal interphalangeal joint. Recontracture developed in 1 (2.2%) patient due to irregular follow-up and non-compliance to usage of splint and physiotherapy.

**Conclusion:** The majority of cases of post burn flexion contracture were noted in the paediatric age group. Contracture release and coverage with skin grafting, followed by strict postoperative splinting and physiotherapy, provided a good functional outcome.

**Keywords:** Finger deformity, Local flap, Reconstructive surgeries, Skin graft

## INTRODUCTION

Burns involving the hand cause debilitating abnormalities that can limit daily activities [1]. The most common sources of burns are thermal (fire/flame, scalds, hot objects), electrical, and chemical agents, respectively [2]. Nearly one-fourth of all burn injuries occur in children under the age of 16 years, with the majority being under the age of five years [3]. Children are particularly susceptible to burn injuries, especially scalds due to spillage of hot liquids; the part of the body most commonly affected is the hand [4].

Burns classified as first and superficial second-degree generally heal within about two weeks, resulting in satisfactory functional and esthetic outcomes. In contrast, deep second-degree (partial-thickness), third-degree (full-thickness), and fourth-degree (involving tendon, bone, nerve, or joint) burns heal more slowly, leaving scars and potentially requiring surgical intervention such as debridement and wound coverage [5]. Early initiation of physical therapy, splinting, passive exercises, topical treatments, early excision, and grafting when indicated, along with a multidisciplinary approach, are crucial treatment principles [6].

Appropriate procedure selection and surgical timing, followed by supervised rehabilitation, can be lifesaving for a burn survivor [7]. Assessment of the affected area, depth of the burns, underlying structures involved, joint status, and functional morbidity is a complex diagnostic goal that is essential for achieving better outcomes through precise planning [8]. Reconstructive surgeries performed for the treatment of post burn hand deformities include Z-plasty, skin grafting, local flaps, and regional flaps [9].

The rationale of this study was to assess the etiology of post burn flexion contractures of the fingers, to examine the appropriate choice of reconstruction, the timing of surgery, and its functional outcomes.

## MATERIALS AND METHODS

A prospective observational study was conducted in the Department of Plastic and Reconstructive Surgery at SSIMS & RC, Davangere, Karnataka, India, from March 2021 to February 2024. Consent was obtained from all study participants. A sample size of 45 patients with post burn flexion contractures of the fingers, who fulfilled the inclusion criteria and underwent the procedure within the stipulated duration of the study period, constituted the sample population.

### Inclusion criteria:

- Post burn flexion contractures involving the interphalangeal and metacarpophalangeal joints.
- Patients aged 1 to 60 years, including both males and females.

### Exclusion criteria:

- Post-traumatic contractures.
- Post burn contractures less than six months old and immature scars.

Demographic details of the patients, such as age, sex, and address, were recorded. A history was taken with special emphasis on the etiology of the burn, the initial management in the acute phase, and whether the patient was managed conservatively

with topical applications and dressings or underwent surgery in the form of debridement and skin grafting. A general examination was performed to exclude any medical problems and to assess other burn deformities. Physiotherapy was provided for all cases of post burn contracture in the fingers to decrease joint stiffness and maximise release.

A local examination was conducted to assess the involvement of the dominant hand, the grade of the contracture, and the maturation of the scars. McCauley classified burn scar contractures into four grades of severity [10]:

**Grade I:** Symptomatic tightness but no limitation in range of motion, with normal architecture.

**Grade II:** Mild decrease in range of motion without significant impact on activities of daily living, and no distortion of normal architecture.

**Grade III:** Functional deficit noted, with early changes in the normal architecture of the hand.

**Grade IV:** Loss of hand function with significant distortion of the normal architecture of the hand.

A subset classification for Grade III and Grade IV contractures includes:

A: Flexion contractures

B: Extension contractures

C: Combination of flexion and extension contractures.

The functional outcome, in the form of range of motion, was assessed by measuring the preoperative contracture angle using a goniometer and determining whether full extension was achieved postoperatively. Surgical intervention for post burn contractures was not performed during the active phase of healing and scarring, when the scar was immature and highly vascular, which usually takes 6 to 12 months for maturation.

The appropriate operative procedure was determined according to the degree and site of the contracture, as well as the condition of the surrounding skin. In cases of mild contractures, release was performed using multiple Z-plasties, utilising the available surrounding skin. In instances of thick, severe post burn flexion contractures, contracture release and coverage with a skin graft or local flap were performed.

Apparent and true defects were estimated by measuring from the opposite hand, and a template was created and sterilised. Under general anaesthesia, the patient was placed in a supine position, and both the hand and donor area were prepared and draped. A tourniquet was applied to the respective arm. The area to be released was infiltrated with tumescent anaesthesia fluid to facilitate dissection and minimise bleeding. The procedure was performed under loupe magnification to avoid injury to digital vessels, as these vessels were either displaced from their normal positions or at risk of spasm during the release, especially in children. Incisional contracture release was executed at right angles to the contracture, extending from one neutral line to another. The release was performed 360 degrees with fishtailing and back cuts into the normal skin to avoid a straight-line scar and to ensure complete release. A single axial K-wire was used to maintain the extension of the interphalangeal joints.

After the tourniquet was released, haemostasis was achieved, and capillary refill of the fingertip was confirmed. The raw area was resurfaced using thick split-thickness skin grafts, full-thickness skin grafts, or local flap cover. Bolster dressings were applied, and Plaster of Paris (POP) splints were placed with the fingers in extension.

On the fifth postoperative day, primary dressings were performed for graft cases, and splints were reapplied. Patients were discharged after two dressings if the flaps were healthy or after good graft uptake. Follow-up visits were scheduled for two weeks, one month,

three months, and six months to monitor progress. Physiotherapy was advised once the graft had settled, usually after two weeks. Splints were to be worn continuously for the first three months and only during the night for the next three months. Meanwhile, moisturising massages were to be performed daily.

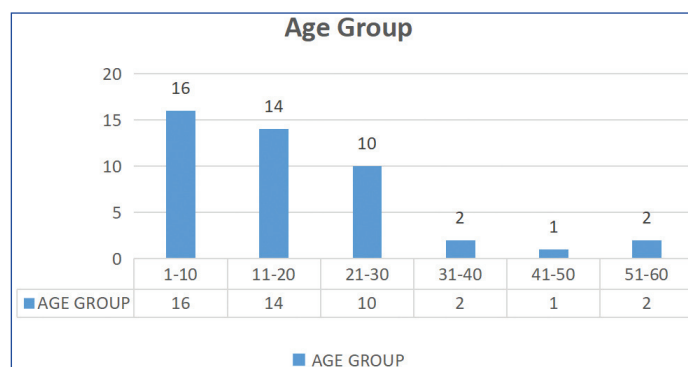
## STATISTICAL ANALYSIS

All the data were analysed using MS Excel software (Version 2013). Descriptive statistics were employed, and the results were expressed in terms of frequency and percentages.

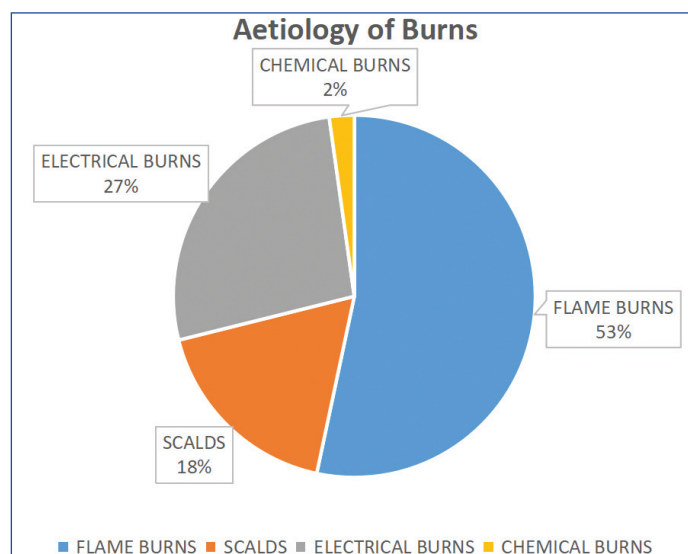
## RESULTS

In this study, the patients' ages ranged from 1 to 60 years. 16 (35.5%) patients belonged to the age group of 1-10 years, while 14 (31.1%) patients were aged 11-20 years [Table/Fig-1]. 18 (40%) cases were female, and 27 (60%) cases were male. A total of 26 (57.8%) patients had finger contractures in the right hand, whereas 19 (42.2%) patients had finger contractures in the left hand. Additionally, 28 (62.2%) patients were affected in their dominant hand, restricting their activities of daily living.

The most common etiological factor was flame burns, affecting 24 (53.3%) patients, followed by electric burns in 12 (26.7%) patients, scalds in 8 (17.8%) patients, and chemical burns in 1 (2.2%) patient [Table/Fig-2]. A total of 37 (82.2%) patients had a history of conservative treatment, while 8 (17.8%) patients had a history of debridement with skin grafting during the initial management of the acute phase of their burns.



[Table/Fig-1]: Age group of patients.

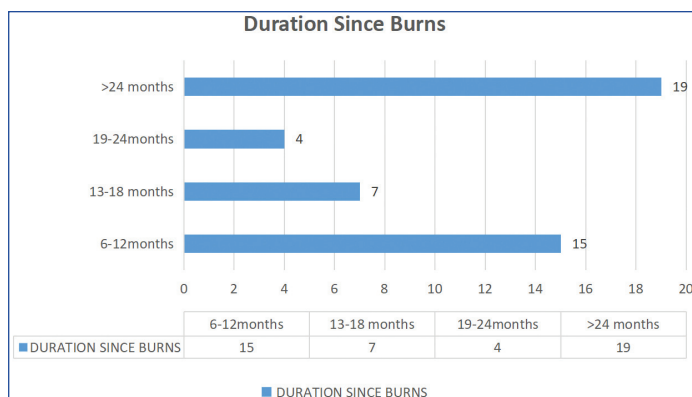


[Table/Fig-2]: Etiology of burns.

Based on McCauley's severity grading [10], 3 (6.7%) patients sustained grade II contractures, 36 (80%) patients had grade III contractures, and 6 (13.3%) patients sustained grade IV contractures.

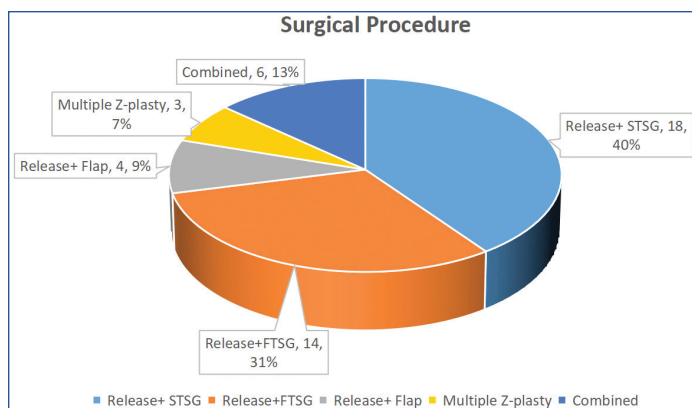
About 15 (33.3%) patients were operated on between 6 and 12 months post burn, 7 (15.6%) patients between 13 and 18 months,

4 (8.9%) patients between 19 and 24 months, and 19 (42.2%) patients more than 24 months after the burn [Table/Fig-3].

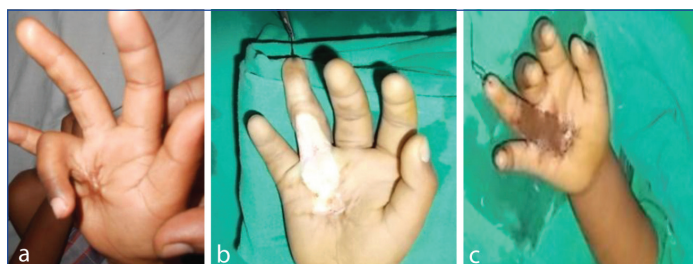


[Table/Fig-3]: Duration since burns.

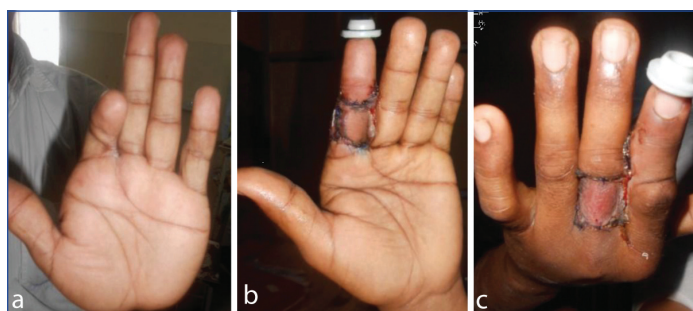
Various surgical procedures were performed for the reconstruction of post burn flexion contractures of the fingers [Table/Fig-4]. Contracture release and STSG was done in 18 (40%) patients, while release and FTSG was done in 14 (31.1%) patients [Table/Fig-5]. Release and local flap surgery were conducted in 4 (8.9%) patients [Table/Fig-6], multiple Z-plasty was performed in 3 (6.7%) patients, and a combination of skin grafting and multiple Z-plasty was done in 6 (13.3%) patients [Table/Fig-7].



[Table/Fig-4]: Surgical procedures performed.



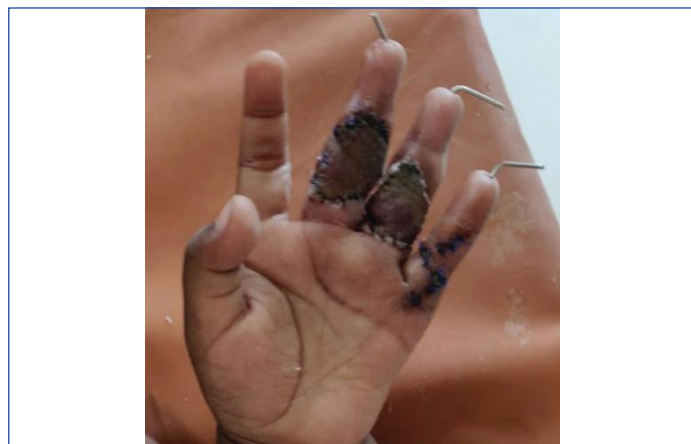
[Table/Fig-5]: 1. a) Preoperative, b) Intraoperative, and c) Immediate postoperative images of post burn flexion contracture of the right ring finger for which contracture release + K-wire + FTSG were performed.



[Table/Fig-6]: Post electrical burn contracture over left index finger underwent contracture release + K-wire + cross finger flap.

A complication was noted in two patients in the form of partial graft loss, which healed with regular dressings. Full extension of the fingers at the interphalangeal joint was achieved after contracture

release in 44 (97.8%) patients. In 1 (2.2%) patient, residual flexion of 10 degrees was noted at the distal interphalangeal joint.



[Table/Fig-7]: Postoperative image of contracture release + FTSG for middle and ring fingers as well as Z-plasty for little finger.

Recontracture developed in 1 (2.2%) patient due to irregular follow-up and non compliance with the use of splints and physiotherapy.

## DISCUSSION

Post burn flexion contractures of the fingers are predominantly observed in the paediatric population. In this study, the patients' ages ranged from 1 to 60 years, with the most common age groups being 1-10 years (35.5%) and 11-20 years (31.1%). This is consistent with the study by Tucker SC [11], where the age range was 1 to 55 years, with a mean age of 14 years. In the study by Kaltungo ZY et al., the mean age was found to be eight years [12]. In the research conducted by Bai SPL and Gunasekaran R, children aged <12 years constituted 42% of the patients in their study [13].

In the present study of 45 patients, 24 (53.3%) patients sustained flame burns, 8 (17.8%) patients sustained scalds, 12 (26.7%) patients sustained electric burns, and 1 (2.2%) patient sustained chemical burns. In the study by Kaltungo ZY et al., 16 (48.5%) patients sustained scalds, 7 (21.2%) patients sustained flame burns, 3 (9.1%) patients sustained electrical contact burns, and 7 (21.2%) patients sustained other types of burns [12]. In the study by Sridhar R and Hariharan SC, 12 (25%) patients sustained scalds, 10 (21%) patients sustained flame burns, and 10 (21%) patients sustained electrical burns [14].

The classic rule of burn surgery is to delay secondary procedures until scars have fully matured, which typically takes approximately one year. However, in patients with severe skin contractures that restrict motion, surgical intervention is necessitated before the scar has fully matured to prevent secondary tendon and joint contractures [9]. In this study, the duration between the acute burn and contracture release surgery ranged from six months to eight years. This is similar to the study by Tucker SC, where the delay from the burn to the first presentation at this facility ranged from nine months to 35 years [11]. Similarly, in the study by Kaltungo ZY et al., this interval ranged from one month to 16 years [12]. In the study by Sridhar R and Hariharan NC, the interval between burns and surgical treatment varied from 7 months to 23 years [14].

When a hand is severely affected by contracture, the choice of the initial set of procedures is crucial, as it significantly impacts the functional outcome of the surgery for the patient [8]. Excision of the scar tissue and correction of the deforming forces, followed by soft-tissue reconstruction, are necessary for the amelioration of the deformity [11]. In this study, release and STSG was done in 18 (40%) patients, release and FTSG was done in 14 (31.1%) patients, multiple Z-plasties in 3 (6.7%) patients, cross-finger flaps in 4 (8.9%) patients, and combined procedures in 6 (13.3%) patients. In the study by Bai SPL and Gunasekaran R, which comprised 60 patients with post burn flexion contractures, release and STSG were



performed in 25 (41.7%) patients, release and FTSG was done in 7 (11.7%) patients, multiple Z-plasties in 10 (16.7%) patients, finger webspace release in 10 (16.7%) patients, cross finger flaps in 5 (8.3%) patients and distant flaps in 3 (5%) patients. [13]. Distant flaps, such as groin and abdominal flaps, were avoided as they would result in bulky, insensate skin for the fingers.

In this study, partial graft loss was observed in 2 (4.4%) patients who were managed conservatively with regular dressings. This is similar to the study by Tucker SC, where complications were noted in 3 (7%) patients [11]. Additionally, there was one complete graft failure of a full-thickness skin graft that was treated with a split-thickness graft [11]. In the study by Kaltungo ZY et al., complications were noted in 13 (39%) patients. These included wound infection in 10 (30.3%) patients, graft shift in 1 (3%) patient, and digital tip gangrene in 2 (6%) patients [12]. In the study by Sridhar R and Hariharan NC, no immediate postoperative complications were reported [14]. In the study by Sunil NP et al., complications were observed in 1 (2%) patient, specifically in the form of partial flap loss [15].

In the present study, full extension of the fingers at the interphalangeal joint was achieved in 44 (97.8%) patients, but in one patient, there was 10 degrees of residual flexion at the Distal Interphalangeal (DIP) joint. Stern PJ et al. reported that 88% of patients with surgically treated flexion contractures had less than 20 degrees of residual contracture [16]. They also found that older patients and those with more severe contractures had poorer outcomes. In their study, among 24 patients with post burn flexion contractures, Patil AJ et al. observed that the majority of patients had significant improvement in total active range of motion postoperatively after six and 12 months [17].

### Limitation(s)

In the present study, follow-up was conducted until six months postoperatively; however, a longer follow-up period would be more ideal, as scar remodelling and maturation can continue for several months to years. Additionally, sensory assessment was not performed on the reconstructed part of the finger.

### CONCLUSION(S)

Children were more commonly affected by post burn flexion contractures, which were predominantly caused by thermal burns.

The timing of surgery, following scar maturation with maintenance of joint suppleness, along with the selection of an appropriate reconstructive option and a strict postoperative regimen of physiotherapy and splinting, are imperative for optimal functional rehabilitation of the hand.

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#### PARTICULARS OF CONTRIBUTORS:

1. Assistant Professor, Department of Plastic and Reconstructive Surgery, SS Institute of Medical Sciences and Research Centre, Davangere, Karnataka, India.
2. Professor and Head, Department of Plastic and Reconstructive Surgery, SS Institute of Medical Sciences and Research Centre, Davangere, Karnataka, India.
3. Senior Resident, Department of Plastic and Reconstructive Surgery, SS Institute of Medical Sciences and Research Centre, Davangere, Karnataka, India.
4. Senior Resident, Department of Plastic and Reconstructive Surgery, SS Institute of Medical Sciences and Research Centre, Davangere, Karnataka, India.

#### NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

GB Karthik,  
Door 697/1, 8<sup>th</sup> Main, PJ Extension, Davangere, Karnataka, India.  
E-mail: gbkarthik22@gmail.com

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