



**Research Article**

**A STUDY OF RESURFACING OF ELBOW DEFECTS FOLLOWING RELEASE OF POST BURN CONTRACTURE WITH DIFFERENT LOCO-REGIONAL FLAPS**

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**ABSTRACT**

The present study prospectively analyzed 38 patients with post-burn contractures of the elbow who were treated in the Department of Plastic Surgery, Medical College Kolkata in the period between January 2016 and September 2017. The patient age ranged from 4 years to 60 years and maximum number of patients belonged to the age group of 12-60 years (74% of all patients). There were 13 males (34%) and 25 females (66%) in the study. 32% of the contractures were of the longitudinal band type and the remaining 68% were of total (diffuse) type contracture. According to the severity of contracture, there were 14 elbows with mild contracture (36.8%), 15 elbows with moderate contracture (39.5%), and 9 elbows with severe contracture (23.7% cases) as per the standard classification system based on the degree of loss of elbow extension. The operative procedure was chosen according to the type and severity of elbow contracture, size of the defect after contracture release, and condition of the surrounding skin. The various reconstructive procedures used for resurfacing elbow contractures in the study were Reverse Lateral Arm Flap (RLAF) in 13 cases (34%), Multiple Z-plasty in 5 cases (13%), Reverse Medial arm fasciocutaneous flap in 7 cases (18%), the Square flap in 7 cases (18%) and the Proximal Radial Artery Perforator flap (PRAPF) in 6 cases (16%). In this study, multiple Z-plasty, Square flaps were used only in cases of band contractures of elbow. The other fasciocutaneous flaps were used for diffuse type of contractures. Patients were followed up for at least 6 months after surgery. Functional recovery of elbow joint mobility was assessed by measuring the gain in the angle of maximum elbow extension possible at 6 months after surgery. Achievement of full elbow extension was possible in 78% cases of mild contracture, 86% cases of moderate contracture, and 55% cases of severe contracture. Overall functional improvement in the study was satisfactory, with achievement of full elbow extension in 76% cases (29 out of the total 38 cases) in the study. However, the functional results varied slightly across the different surgical procedures. There was no recurrence of contracture in the procedures. Overall, the complications were minimal, and there was no flap loss. There was minimum donor area and recipient site morbidity. The aesthetic results were acceptable to majority of patients.

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**INTRODUCTION**

The mortality and morbidity from burns have diminished tremendously over the last few decades. However, these do not truly reflect whether the patient could go back to society and lead a normal life because of the inevitable post-burn scars, contractures and other deformities, which collectively have aesthetic and functional considerations. Full hand motion is not possible if elbow contracture prevents the hand to keep in optimal functional position. Elbow contractures commonly result from deep burn especially when adequate rehabilitation such as active and passive exercises, use of pressure garments and immediate splinting in extension and forearm supination are not given to the patient. Contractures also form in cases of full thickness skin burns when primary grafting is not done.

After release of these contractures the resulting raw areas need a suitable covering. The methods of resurfacing range from split-thickness skin graft, Z-plasty, square flap, various local and regional flaps up to the most complicated repair with a microvascular free flaps. Each technique has its advantages and disadvantages. It is of prime importance to assess the efficacy of different procedures so far as functional recovery and aesthetic improvement is concerned. The focus of the present study is to evaluate the different surgical procedures for reconstruction of post burn contractures of the elbow in terms of functional and aesthetic outcome.

**MATERIALS AND METHODS**

**Study Area:** Department of Plastic and Reconstructive Surgery, NRS Medical College, Kolkata.

**Study population:** Patients with post-burn elbow contractures, who had attended Plastic Surgery outpatient department of Medical College, Kolkata and undergo reconstructive surgical

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procedures in the period from January 2016 to September 2017.

**Exclusion Criteria:** i) Refusal by the patient to enrol in to study. ii) Patients having pre-existing elbow joint pathology (e.g. heterotrophic ossification, osteoarthritis). Iii) Patients older than 60 years.

**Study period:** The study was conducted over a period from January 2016 to September 2017.

**Sample size:** The sample size was 38 patients.

**Sample design:** Consecutive sampling of all eligible cases during the study period.

**Study design:** Prospective observational study.

**Parameters studied:** i) Age, Sex distribution of study population, ii) Type and Severity of post burn elbow contractures. iii) Range of motion of elbow joint, iv) Aesthetic outcome. v) Recurrence of contracture. vi) Recipient site complication. vii) Requirements of second operation. viii) Donor site morbidity.

**Study Tools:** a. Case record form. b. Goniometer. c. Doppler ultrasound probe (hand-held) used to locate the perforators d. Skin markers, measuring tapes, surgical loupes for magnification during dissection. e. Predetermined proforma for tabulation of data. f. Camera for taking preoperative, intraoperative & postoperative photographs.

**Study Technique:** Standard operative protocol of the institute was followed in the study. All the patients were informed about the risks and benefits of each operation and asked to sign an informed consent form in their respective native language. Patients admitted with post-burn elbow contracture in the Department of Plastic Surgery were grouped into two categories according to their anatomical type as: Band contracture: when scarring results in a fold formation along the medial, lateral or central band. Diffuse (or total) elbow contracture: when scarring involves whole of the cubital fossa skin. Options of surgical treatment were chosen according to the contracture type, severity and the condition of the surrounding tissues.

- ✓ Site & type of contracture were identified.
- ✓ State of adjacent skin was assessed for scarring.
- ✓ Angle of elbow extension and flexion was measured by goniometer and classified :

(according to Bennett *et al*)-(a) Negligible: those with less than 10° of extension loss . (b)Mild:those with greater than 11–49° extension loss (c)Moderate: those with greater than 50–89° extension loss (d)Severe: those with greater than 90° extension loss. [The accepted nomenclature for describing elbow flexion–extension range of motion is that of the American Academy of Orthopaedic Surgeons. They defined the fully extended position, with a straight arm, 36 as 0°, and the fully flexed position to be approximately 146°.] The sample population had undergone routine preoperative evaluation. Choice of reconstruction were best judged preoperatively and appropriate local flaps were provided for the defect. Various loco regional flaps viz. Z-plasty, square flap,V-Y plasty, local advancement flaps, rotation flaps, transposition flaps, island flaps, peninsular flaps, reverse lateral arm flaps, reverse medial arm flaps, radial artery perforator flaps etc. were used for resurfacing the elbow defects following release of post burn

elbow contracture. Now these flaps were evaluated for the above mentioned parameters in the immediate postoperative period as well as in long term in outpatient department in periodic intervals. Results were recorded and photographs were taken for documentation. Post-operative flap monitoring were done by periodical clinical assessment and with the help of hand held Doppler. Post-operative follow-up for early and late wound complications of both the flap and the donor site and their functional and aesthetic outcome were noted. The average time of follow-up were of 6 months. Patients were advised to attend the follow up clinic after 1 month, 3 months and 6 months after discharge. All the relevant data for each patient were recorded in a pre-designed tabular proforma.

**RESULTS**

The present study included patients with post-burn elbow contracture who were admitted in the Department of Plastic and reconstructive Surgery in Medical College, Kolkata. The study was conducted over a period of 21 months between January 2017 and December 2017. A total of 38 patients with post-burn elbow contractures were included in the study. The patients were followed up for at least 6 months post-operatively. All the 38 patients were available for analysis of data. The different reconstructive surgical modalities were studied with regards to the functional and aesthetic outcomes.

**Table 1** Age-wise distribution of patients in the study

Age group	Number of patients	Percentage (%)
Up to 12 years	10	26.31
>12 – <60 years	28	73.69
Total	38	100

Table 1 shows the age distribution of patients in the study. The age- range of the patients was 4 - 60 years. Maximum number of patients belonged to the age group of 12-60 years (74%). There were 13 males (58%) and 25 females (42%) in the study.

**Table 2** Sex distribution of patients in the study

Type	Number	Percentage (%)
Male	13	34.21
Female	25	65.79
Total	38	100

**Table 3** Types of elbow contracture in the study

Type	Number	Percentage (%)
Band contracture	12	31.58
Total (diffuse) contracture	26	68.42
Total	38	100

Among the 38 total cases, there were 12 cases of longitudinal band contracture and 26 cases of diffuse contracture of elbow (Table 3)

**Table 4** Severity of elbow contractures in the study

Degree of extention loss at elbow	Number	Percentage (%)
Mild contracture (11-49*loss of extention)	14	36.5%
Moderate contracture (50-89* loss of extention)	15	39.5%
Severe contracture (>90*loss of extention)	9	23.7%
Total	38	100

**Table 5** The different surgical procedures performed in the study

Procedure	Number of cases	Percentage (%)
Reverse Lateral arm flap	13	34.2
Multiple Z-plasty	5	13.0
Reverse Medial arm fasciocutaneous flap	7	18.5
Square flap	7	18.5
Proximal Radial Artery Perforator flap	6	15.8
Total	38	100

The various reconstructive procedures used for resurfacing elbow contractures in the study are enumerated in Table 5. Out of the total 38 patients, contracture release with Reverse Lateral Arm Flap was performed in 13 cases, Multiple Z-plasty was used in 5 cases, Reverse Medial arm fasciocutaneous flap in 7 cases, Square Flap in 7 cases and the Proximal Radial Artery Perforator flap in 6 cases

**Table 6** Use of different surgical procedures in the study according to type and severity of elbow contracture

Surgery performed (n = 38)	Band contracture (n = 12)			Diffuse contracture (n = 26)		
	Mild	Moderate	Severe	Mild	Moderate	Severe
Reverse Lateral Arm Flap (n = 13)	0	0	0	5	4	4
Multiple Z-plasty (n = 5)	5	0	0	0	0	0
Reverse Medial arm fasciocutaneous flap (n = 7)	0	0	0	2	5	0
Square Flap (n = 7)	2	5	0	0	0	0
Proximal Radial Artery Perforator Flap (n = 6)	0	0	0	0	1	5

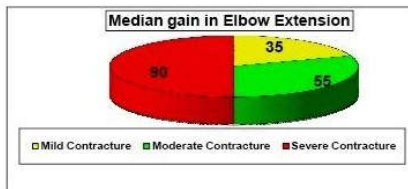
The choice of reconstructive procedure was based on the type of elbow contracture (band or diffuse) and the severity of contracture, as elaborated in Table 6.

**Clinical outcomes:**

**Recovery of elbow joint mobility:** This was assessed by measuring the increase in the angle of maximum elbow extension possible at 6 months after surgery.

**Table 7:** Results of assessment of elbow mobility 6 months after surgery

Severity of elbow contracture	Gain in elbow joint extension		
	Minimum	Maximum	Median
Mild contracture (11- 49° loss of extension) (n = 14)	20°	45°	35°
Moderate contracture (50-89° loss of extension) (n = 15)	45°	65°	55°
Severe contracture (≥90° loss of extension) (n = 9)	75°	90°	90°

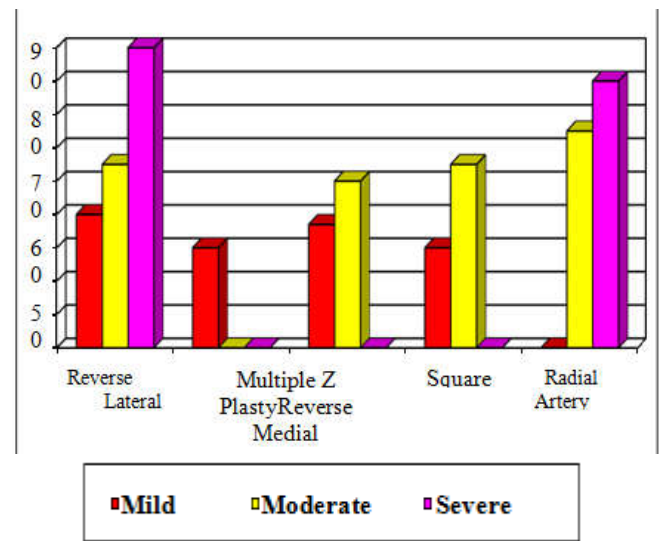


The median post-operative gain of elbow extension in the mild, moderate and severe contracture groups were 35° (range 20°- 45°), 55° (range 45°- 65°) and 90° (range 75°- 90°) respectively (Table 7). Achievement of full elbow joint extension was possible in 78.5% (11 out of 14) cases of mild contracture, 86.6% (13 out of 15) cases of moderate contracture, and 55.5% (5 out of 9) cases of severe contracture. Overall, full elbow extension was achieved in 76% cases (29 out of the total 38 cases) in the study.

**Table 8:** Recovery of elbow extension with different surgical procedures at 6 months after surgery

Procedure	Median increase in elbow extension (degrees)		
	Mild contracture	Moderate contracture	Severe contracture
Reverse Lateral arm flap	40°	55°	90°
Multiple Z-plasty	30°	NA	NA
Reverse Medial arm fasciocutaneous flap	37.5°	50°	NA
Square flap	30°	55°	NA
Proximal Radial Artery Perforator flap	NA	65°	80°

**Regain of Elbow Extension with Different Flaps after six months**



The recovery of range of elbow joint extension in all the three groups (i.e., mild, moderate and severe contracture) varied slightly across the different surgical procedures as shown in Table 8

**Recurrence of Contracture**

**Table 9** Recurrence of elbow contractures after surgery

Procedure	Total number	Recontractures	Percentage (%)
Reverse Lateral Arm Flap	13	0	0
Multiple Z-plasty	5	0	0
Reverse Medial arm fasciocutaneous flap	7	0	0
Square Flap	7	0	0
Proximal Radial Artery Perforator flap	6	0	0

The incidence of contracture recurrence after reconstruction is shown in Table 9.

At 6 months follow up after surgery, in this study, there was no recontracture. No post operative splinting was required in flap reconstructions.

**Recipient site Complications**

**Table 10** Recipient site complications

Complications	Number	Procedures done
Flap necrosis	3	Multiple Z-plasty (tip necrosis) in 2 cases Proximal Radial Artery Perforator flap (partial necrosis) in 1 case
Wound dehiscence	0	-
Hypertrophic scar	0	-

**Table 10** enumerates the recipient site complications occurred in the study. There was minor flap tip necrosis in two cases of multiple Z-plasty both of which healed secondarily. Also, there was partial flap necrosis of Proximal Radial Artery Perforator flap in a single case, which was managed by debridement and skin grafting.

There was no wound dehiscence or hypertrophic scar at the recipient sites.

**Donor site Morbidity**

**Table 11** Donor site morbidity

Complications	Number	Procedure done
Hypertrophic scar	5	STSG in 5 cases
Wound dehiscence	0	-
Graft rejection	0	-

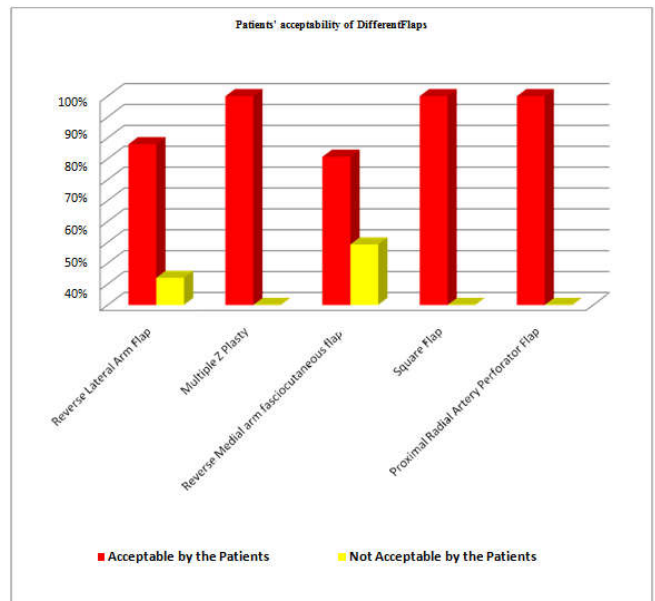
**Table 11** above lists the donor site morbidity. There was hypertrophic scar formation at the STSG donor site in five cases, which was managed by local application of steroid ointment and pressure garment.

Skin graft take at the donor site varied from 80% to 100%. There was no wound dehiscence at the donor area.

**Aesthetic Acceptance by Patients**

**Table 12** Aesthetic outcome

Procedure	Patient acceptability	
	Yes	No
Reverse Lateral Arm Flap (n=13)	10(77%)	3(13%)
Multiple Z-plasty (n=5)	5(100%)	0
Reverse Medial arm fasciocutaneous flap (n=7)	5(71%)	2(29%)
Square flap (n=7)	7(100%)	0
Proximal Radial Artery Perforator flap (n=6)	6(100%)	0



**Table 12** shows the aesthetic outcome of the different flaps, used in the study, in terms of patients' acceptance.

From the table it is seen that 77% of the patients of the Reverse Lateral Arm Flap group accepted the flap, but 13% did not. Similarly 71% patients of the Reverse Medial arm fasciocutaneous flap group well accepted the flap but 29% did not. But 100% patients of the Z plasty, Square Flap & Proximal Radial Artery Perforator flap group accepted the respective flaps well.

**Need for Second Operation**

No second operation was required for the complications at donor area in the study. There were Hypertrophic scar at the sin grafted donor site in five cases. All were managed well with application of pressure garments, silicone gel sheets and topical steroid ointments.

Three cases of complications were taken place in the recipient sites. There was Tip necrosis in two cases of Z plasty, which were ultimately healed automatically. Partial flap necrosis was taken place in a case of Proximal Radial Artery Perforator flap, which was managed by skin grafting.

**Follow up:** The median follow up of patients in the study was 11 months (range 6 - 20 months), all the patients being followed up for at least 6 months post-operatively.



Preoperative





After release of contracture



After giving inset of the flap



Post operative photograph

## DISCUSSION

Upper extremity burn contractures are a major challenge to the reconstructive surgeon. Flexion contracture of the elbow is a common consequence of severe burn. Elbow contractures commonly result from deep burn especially when adequate rehabilitation such as active and passive exercises, use of pressure garments and immediate splinting in extension and forearm supination are not given to the patient. Contractures also form in cases of full thickness skin burns when primary grafting is not done. After release of these contractures the resulting raw areas need a suitable covering. The methods for resurfacing range from split-thickness skin graft, Z-plasties, local and regional flaps, up to the most complicated repair with free microvascular flaps. Each technique has its own advantages and disadvantages. The present study is a prospective non-randomized study of 38 patients with post-burn elbow contracture in a single institution over a time period of January 2016 to September 2017. Patients with non-burn elbow contracture and those having elbow joint pathology (heterotopic ossification, osteoarthritis) were excluded from

the study. In this study, out of total 38 patients 13 were male and 25 were female, between 4 years and 60 years of age. Maximum number of patients (74%) 54 belonged to the age group of 12-60 years. The results of different reconstructive surgical procedures, used for resurfacing defects created after release of postburn elbow contractures, were analyzed in terms of improvement of elbow joint mobility, recurrence of contracture, recipient site complications, donor area morbidity, and aesthetic acceptance by the patients.

A number of classification systems for post-burn elbow contracture have been described in the literature. The classification of elbow contractures into mild, moderate and severe types as proposed by Bennett *et al* (1989) has been followed in the present study. According to this classification, majority (76%) of the patients in the present study had mild to moderate contracture. The patients were also classified according to the anatomical type of contracture into (1) longitudinal band contracture (medial, lateral or central) with normal healthy pliable skin on either side, and (2) total or diffuse contracture that extends across the entire antecubital region, to opt for a suitable resurfacing method. In the present study, the options of surgical treatment were chosen according to the contracture type and severity, with individualization. When the cause of the contracture is a longitudinal hypertrophic scar band with pliable skin on either side, local tissue rearrangement with the Z-plasty, Square flaps were used. In patients with longitudinal band contracture planned to resurface with multiple Z-plasty or Square flap, the release procedure was tailored accordingly with preoperative marking. For diffuse elbow contracture, the contracture was released up to the subcutaneous tissue with fish tailing at the apices to gain full or maximum possible extension of the elbow joint preoperatively. The resurfacing procedure was executed according to the size of the defect created, condition of the adjacent skin, preoperative gain in elbow extension, exposed vital structures and, preoperative mapping of the perforators (if perforator flap had been planned for coverage preoperatively). Elbow contractures can be treated with various procedures. The reconstruction of large soft tissue defects at the elbow is hard to achieve by conventional techniques and is complicated by the difficulty of transferring sufficient tissue with adequate elasticity and sensate skin. Local advancement flaps may be considered for elbow soft tissue defect; however, the use of the local advancement flap is restricted by the required skin grafting. In mild and moderate elbow contractures, multiple Z-plasty with combined full thickness skin grafting are successful for releasing the contractures. After releasing the severe contractures, larger defects may be created and fasciocutaneous flap 56 may be required. The microvascular free tissue transfer is rarely indicated for elbow region. Local flaps: In our study, mild band contractures were resurfaced with multiple Z-plasty, Square flap with acceptable functional results with full gain in angle of extension in almost 100% cases. Aesthetically all the patients were satisfied with the postoperative results. In moderate band contractures, Z-plasty seemed insufficient to cover the extensive raw area, and therefore local advancement flaps, Square flap were used in such cases, depending on the condition of the forearm skin and perforator. Using the local flaps in the moderate contracture group full extension in more than 85% cases (13 out of 15 patients) were achieved in our study. Linear and cord-like burn scar contractures are commonly treated by severing the scar in a transverse direction and performing Z-plasties. According to

Schwartz (2007) a thin band contracture can be managed with a five-flap release V-Y or Z-plasties. [Lai *et al* (1995) are of the opinion that Z-plasty and Y-V-plasty can be used only for treatment of cordlike or linear burn contractures. Güven *et al* have used multiple Z-plasties with combined skin grafting to release moderate elbow contractures and achieved full range of motion in 3.6-year follow-up period. When the flexion contracture of elbow is limited with a solitary 57 longitudinal scar band, Z-plasties are often recommended. However, they sometimes fail to release the entire contracture, and the Z-plasty requires undermining flaps in scarred skin which may lead to the distal tip necrosis. Arasteh and Yavari (2012) recently recommended multiple running Y-V plasty as a very useful and safe technique for the treatment of linear and cordlike burn contractures. Contrary to Z-plasty, the angles and number of Y flaps play no role in the ultimate gain in scar length and degree of contracture release. This principle provides flexibility in planning and freedom in adjusting the amount of skin elongation. The advantages of the propeller flap are easy design and rapid flap elevation that permits a single stage correction of the deformity without further sacrificing an artery or muscle. Unlike Y-V plasty, trapezoid flaps have a wide end, stable blood circulation; they do not undergo rotation, therefore, do not undergo necrosis; contractures are eliminated in full without relapse. The propeller flap has also been used in the elbow with success. The advantages of this method are easy design and rapid flap elevation that permits a single stage correction of the deformity without further sacrificing an artery or muscle. Aslan *et al* (2006) reported sufficient elbow extension and an acceptable aesthetic outcome in seven patients.

In the present study, for the mild and moderate band contracture group we used multiple Z-plasty in 58 cases, Square flaps in 7 cases with satisfactory functional and aesthetic outcomes. Fasciocutaneous flaps: In our study, we used the fasciocutaneous flaps, namely the Reverse Lateral Arm flap, Reverse Medial arm fasciocutaneous flap, Proximal Radial Artery Perforator flap in those cases of total elbow contracture where resurfacing with skin grafts was not justified either due to exposure of underlying vital structures or because full extension was not achieved preoperatively. Full extension of elbow was achieved in 55% cases (5 out of 9 cases) of severe contracture in the patients with severe contracture using either Reverse Lateral Arm Flap or Proximal Radial Artery Perforator Flap. There was minimal operative morbidity (partial flap necrosis in a case of Proximal Radial Artery Perforator flap and in two cases of Z-plasty) in the flap reconstruction group. There was no recurrence of contracture. Aesthetic outcome were satisfactory. In patients with severe contractures, sequential release of deeper structures may be indicated. After such surgery, the bed may be unfavorable for grafting, and in such cases flap coverage is indicated. Flap coverage is also indicated when subsequent deep reconstructive surgery, such as nerve or tendon repair, is contemplated. Local fasciocutaneous flaps when available, facilitates closure of the tissue defect for elbow region considerably in cases where there is exposure of vital structures after release of contracture. Fasciocutaneous flaps are thin, reliable, one-stage procedures, and the flaps are easily harvested without any subsequent functional impairment since the underlying muscles are left intact. Muscle-containing flaps are generally too bulky to use in joints, and may interfere with elbow flexion. [30] When vascularized tissue is required, a

fasciocutaneous flap is indicated as long as adequate perfusion to the distal extremity is ensured. Fasciocutaneous flaps have been shown to be reliable solutions for covering defects after release of postburn elbow contractures. Stern *et al* (1985) suggested that larger elbow contractures can be managed by a forearm transposition fasciocutaneous flap to cover the joint, and remaining defects above or below the flap can be grafted. The medial distal arm has been described by Maruyama *et al* (1987) as a potential donor site for the fasciocutaneous flap because of its excellent color, fine texture, and ideal thickness. The surgical technique is comparatively simple and quick. The reverse medial arm flap seems to be a suitable option for moderate contractures of elbow when there are exposed vital structures or preoperative full extension has not been achieved. Due to the inherent property of the flap to expand and grow there are minimal chance of recontracture especially in case of children. Additionally postoperative gradual extension splintage can be used if full extension 60 not achieved. Kadry *et al* (1989) reported partial flap necrosis in 2 cases and superficial skin loss in 2 cases out of 12 cases of elbow contracture resurfacing by the Reverse Medial arm fasciocutaneous flap. In the present study, achievement of full elbow joint extension was possible in 78.5% (11 out of 14) cases of mild contracture, 86.6% (13 out of 15) cases of moderate contracture, and 55.5% (5 out of 9) cases of severe contracture. Overall, full elbow extension was achieved in 76% cases (29 out of the total 38 cases) in the study. Stern *et al* (1985) using a variety of techniques, reported full restoration of elbow extension in 82% of contractures less than 50° and in only 50% in contractures greater than 50°. Yang (1989) reported satisfactory results in 11 of 12 patients using a reverse medial arm flap, although all but one of these contractures were less than 50°. Overall, results with elbow releases have a lower success rate than other joints according to the literature. Limitations of the study: Our study has some limitations. For instance, the sample size is relatively small, and hence it is not possible to adequately compare between the different surgical techniques used for management of elbow contractures in the study. The present study may be used as a basis for conducting further well designed studies with larger number of patients in future.

## **CONCLUSION**

We conclude that the choice of surgical procedure for reconstruction of post-burn elbow contracture should be made according to the anatomical type and severity of contracture and the condition of the surrounding skin, and the treatment approach must be individualized. Proper planning and clinical judgement is essential for a good functional and aesthetic outcome and better patient satisfaction. Z-plasties and local advancement flaps are suitable for mild band contractures; these are relatively simple procedures and whenever feasible, they should always be preferred to more complex flaps because of their proven efficacy and simplicity of technique. Following release of moderate band 63 contractures the raw area is so extensive that Z-plasty procedure would not be sufficient to cover; therefore we recommend Square flaps. In cases of severe contractures, obtaining full release at the first attempt is unusual. After the release, rigorous physiotherapy is needed. Therefore, flap coverage is required. Diffuse type elbow contractures require fasciocutaneous flap reconstruction. The fasciocutaneous flaps like RLAF, PRAPF, RMAF Flap can achieve acceptable functional and aesthetic results with

early postoperative full range of motion in appropriately selected cases. The cosmetic results of local as well as fasciocutaneous flaps are good.

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**Conflicts of Interest:** None Declared.

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