



ROLE OF SQUARE FLAP IN POST BURN AXILLARY CONTRACTURES

General Surgery

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ABSTRACT

Background: Post-burn contractures are a commonly encountered problem and many techniques have been described in their treatment. Z-plasties are the commonest local flap procedure done for linear bands with adjacent healthy tissue. Our aim was to assess the use of square flap technique in axillary contractures. **Methods:** Ten patients with type I and II axillary contractures underwent release by the square flap technique. All cases were followed up for at least one year and analysed for range of motion and aesthetic outcome. **Results:** All cases achieved full range of movement postoperatively with no recurrence during follow up period and a good cosmetic outcome. **Conclusion:** Square flap was shown to be a reliable technique for mild to moderate axillary contractures of the anterior or posterior axillary folds even when there is significant adjacent scarring of chest wall or back of types I and II.

KEYWORDS

Burn; Axillary; Contracture; Square flap

INTRODUCTION

Burns are still a devastating condition in emergency medicine in both developed and developing countries, while the depth and size of the burn are important factors in morbidity and mortality of burn injuries. For those who survive, scarring is the most persisting problem. Also, inhalation injuries and other complications influence the outcome.² The incidence of burns in India is very high and due to various socioeconomic factors, many patients go on to develop complications like burn contractures. Burn contracture of the axilla is an especially debilitating problem as shoulder movement impact the ability to locate the hand in space to perform activities of daily living.³ At the time of injury, the victim usually observes a protective posture in which the arms are tightly adducted and flexed. As a result, anterior and posterior axillary folds are involved but not the axillary fossa.⁴ The best treatment is prevention i.e., good primary care, splinting and regular exercises. Development of contracture is subjected to release of bands by surgery.⁴⁻⁶ Axillary contractures are classified on the basis of site of contracture, involvement of axillary fossa and adjacent scarring, and the surgical treatment varies with each type.^{5,7-9}

Hanumadass et al⁴ has classified axillary contracture as

- Type I: Linear web at anterior or posterior fold with minimal adjacent scarring and no involvement of the hair bearing area;
- Type II: Scar contracture involving either anterior or posterior axillary folds with adjacent skin scarring, but sparing the hair bearing area.;
- Type III: Linear webs at both anterior and posterior axillary folds with or without adjacent scarring, but sparing the hair bearing area; and
- Type IV: Contracture of one or both folds, diffuse adjacent scarring and involving the hair bearing area.⁴

Release and skin grafting is simple to design and perform and can be done in all types of axillary contractures, but there is risk of failure of graft take, re-contracture, long term splint, absence of suitable donor sites in severe burn cases and painful donor sites.^{5,9, 10-12} Local flaps are best suited for contractures having some adjacent healthy tissue that can be used. These include skin elongation procedures such as Z plasty and its modifications, transposition flaps and propeller flaps.⁵

Z plasty is the most commonly performed local skin flap technique⁶ in type I contractures, wherein there is a linear web with healthy adjacent skin.^{2,7,8}

Transposition flaps require healthy adjacent chest wall, back or arm skin that can be transposed after release. Propeller flaps use

apodcutaneous tissue from the axillary hair bearing region based on a random subcutaneous pedicle rotated 90 degrees to resurface the contracture at the axilla.¹³ The disadvantage is that skin grafts are usually required after flap rotation.¹³ Square flap is a local tissue transposition technique first described by Limberg in 1963, later modified by Hyakusoku and Fumiri. 1987 as a method to increase the distance between two points.¹⁴

It is an useful method for scar contracture, various clefts and cryptotia. It gives a theoretical lengthening of 2.80 times the original length and does not the cut across the axillary hair bearing region like Z plasty.^{14,15}

In this study, we have assessed the outcome of the square flap technique in type I and II axillary contractures of various severity.

MATERIAL AND METHODS

This was a prospective randomised study conducted in the department of Surgery, G.R. Medical College, Gwalior and associated with J.A. Group of hospitals from September 2020 to October 2009. A total number 10 patients of post burn axillary contractures entered into the study.

Ten patients of type I and type II axillary post burn contracture underwent release by square flap technique, all cases were followed up for at least 1 year and analyzed for range of motion and aesthetic outcome.

Inclusion Criteria:

- All post burn axillary contracture that presented to our patient department were considered for study.
- Patient willing for at least one year followup.

Exclusion Criteria:

- Post burn contractures other than axillary post burn contractures.
- Unwilling or unable to keep follow up of one year.

Study Technique:

- A square was designed adjacent to the contracture on site of axillary fossa and two adjacent triangular flaps on the other side of contracture.
- The angle of first triangular flap A was kept at 45° and second flap B ranging from 60° to 90° (Figure 1)
- After incision contracted scar tissue was released.
- The square flap was then advance across the area of contracture and adjacent triangular flap were rotated repositioned one on each side of advanced square flap.

RESULT:

The square flap was used in a total of ten-patients in the age group ranging from 6 to 35 years, of which seven were males and three were females. The mean age of the patients was 19.2 years with male:female ratio of 7:3. The mean duration of contracture was 1.8 years. The cause of contracture was thermal burns in all patients. In all cases, the wounds healed with conservative management and patients did not follow any splinting and exercise protocols. Six were involving the anterior axillary fold and four involving the posterior axillary fold. Eight of the cases had associated adjacent scarring (type II) and two had linear webs with healthy surrounding skin.

No skin grafts were needed for cover of the raw area created after release. In one case, there was tip necrosis of triangular flap; but it healed well with conservative management. No other complications were noted post-operatively in any of the patients. All patients were followed up for minimum one year. Pre-operatively, axillary abduction ranged from 35 to 90 degrees with a mean of 62.5 degrees. Complete range of motion (180°) was achieved in all cases and no recurrences were observed (Table 1). Since the square flap was advanced from the axillary fossa, the hair bearing skin was not divided across and transposed, giving a good cosmetic appearance post-operatively. There was also good colour and texture match.

**Table 1 : Data Of Patients Included In The Study**

No.	Age	Gender	Type of axillary contracture	Complication	Follow up (years)	Preoperative range of motion	Range of motion 1 year post-op
1	12	Male	Type 1a (Rt)	Nil	2	80 °	180°
2	24	Female	Type 1b(Lt)	Nil	1.8	90 °	180°
3	18	Male	Type 1a (Rt)	Nil	1.5	80 °	180°
4	25	Female	Type 1a (Rt)	Tip necrosis	1.6	60 °	180°
5	28	Female	Type 1b (Rt)	Nil	1	90 °	180°
6	24	Male	Type 1a (Lt)	Nil	1.8	90 °	180°
7	35	Male	Type 1a (Rt)	Nil	1.7	60 °	180°
8	24	Male	Type 1b (Lt)	Nil	1.3	85 °	180°
9	12	Female	Type 1a (Rt)	Nil	1	35 °	180°
10	24	Male	Type 1b (Rt)	Nil	1	55 °	180°

DISCUSSION

With improved surgical techniques, refinements in the algorithms for management of axillary contractures are in order.^{5,7,8} Level 1 and 2 evidences (randomized studies) are lacking in the field of treatment of burn contractures.⁶ Each case should be individualised based on patient factors (nature of contracture, patient compliance, socioeconomic factors), surgeon factors (skills and experience) in order to achieve desired results in the least resource intense manner.^{16,17} Hanumadass *et al.* recommended Z plasties for type I contractures and release and skin grafting for types II, III and IV (based on his classification).⁴

Sakr *et al.* recommended multiple Z plasties for linear contractures; local transposition and advancement flaps for moderate localized contracture bands with healthy adjacent skin; scapular and parascapular flaps, when local flaps are unfeasible due to scarring; and skin grafts when scapular and parascapular skin is scarred.⁸ According to Ogawa *et al.*'s study, skin grafting should be done if the contracture is small, flat and not involving the fat layer of the axilla; local flaps when contracture involves anterior or posterior axillary folds and spares axillary fossa with minimal adjacent scarring; propeller flap when both folds are involved but fossa is uninvolved; axial local flap (latissimus dorsi flap, parascapular flap, superficial cervical artery flap and bilateral scapular combined flap) when there is adjacent scarring of chest, back or upper arm; free flap and scarring flap when contracture is extensive.⁵

When using local flaps for contractures of both anterior and posterior folds, flaps should be staged.⁶ A single large Z plasty provides good lengthening but large flaps are prone to more transverse tension. Modifications such as multiple Z plasty in series, four-flap, five-flap, and six-flap Z plasties gave lengthening with lesser transverse tension. However, when the angles of the flap are narrow especially in scarred skin, they are prone to tip necrosis. Another disadvantage of Z plasty in axillary contracture is that it divides the hair bearing area of the axilla and displaces a part of it anteriorly over the chest wall, which looks bad cosmetically.^{3,9}

Theoretically, Z plasty and its various modifications can achieve a lengthening of 75 to 150% (1.75 to 2.5 times gain in length of central limb), but the actual lengthening achieved may be lesser in vivo.¹⁸ There are no established guidelines as to which Z plasty should be used where, nor is it specified how severe a contracture can be corrected using Z plasty. Unless the scar is a discrete band, they will not provide the desired result without skin grafting.¹⁹ Square flap is considered a three flap modification of Z plasty that combines flap transposition and advancement. In the original square flap design described before, the design contained a square and two triangular flaps, both having an acute angle.¹⁴

This design was modified by making one of the triangular flaps a right angled one, and was demonstrated better lengthening as compared to Limberg's design (Figure 1). Also, an added advantage was that the suture line was not parallel to the line of lengthening. The lengthening resulting from Z plasty, its various modifications and square flap were assessed geometrically before realising that square flap gave the maximum lengthening. When the angle of the second triangle flap was 90 degrees, it gave a lengthening of 2.8 times, in comparison to Z plasty which gave a maximum lengthening of 2.24 times. Square flap provided a gain in length of almost 180% as per

simple geometric analysis and about 90% elongation when skin elasticity and 3D deformation were taken into consideration by computer aided analysis. The gain in length was more compared to any other methods derived from Z plasty.^{14,15}

More recent studies using stereometric geometric modelling revealed that square flap yields a larger flap area, higher length breadth ratio compared to Z plasties and is associated with the lowest physiological tension, which means that the deformity of the adjacent skin and the dependence on the laxity of the adjacent skin is minimal.²⁰ In addition to contractures, square flap can be used in various clefts (cleft earlobe, cleft palate), cryptotia, and epicanthal folds.^{14,21,22} Several modifications of the square flap have been proposed to better suit its use in clefts, epicanthal folds and contractures.^{14,22,23}

We used the square flap technique in cases with significant adjacent scarring. In a few of our cases, the second triangular flap was taken at 60 degrees instead of 90 degrees, as the severe hypertrophic scarring precluded transposition of a larger angled flap (Figure 1). We achieved good lengthening without tension in all cases, even when initial range of motion was as low as 35° and abduction of 180 degrees was maintained at one year follow up in all cases. Recurrence is unlikely to occur later, if the range of motion is preserved till one-year post-surgery.³

The design is simple and easy to replicate. The contracture is cut across at a point and the square advancement flap breaks the line of the contracture. The final suture line is not parallel to line of lengthening. These are probably the reasons for no recurrence. In the developing world scenario like ours, patients come from poor socioeconomic groups, often travelling from distant regions and are not always compliant with prolonged splinting protocols and follow ups. In square flap technique, postoperative splints were used only for one week. The axillary hair patch was not cut across and displaced giving a better cosmetic appearance. The only complication seen in our series was tip necrosis of a flap, probably due to poor vascularity of the adjacent scar tissue on which the triangular flap was raised.

CONCLUSION

Square flap was shown to be a simple technique and easy to replicate. It gives good lengthening and requires less post-operative splinting with no donor site morbidity and a good cosmetic outcome. In our experience, square flap is a reliable local flap technique for mild to moderate axillary contractures of the anterior or posterior axillary folds even when there is significant adjacent scarring of chest wall or back (types I and II).

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