

Comparison of Gain In Length After Post Burn Contracture Release By Z-Plasty And Square Flap

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ABSTRACT

Objective: To compare the mean differences in gain in length after post-burn contracture release by z-plasty and square flap.

Study Design: Case Series

Place and Duration of Study: Plastic and Reconstructive Surgery Department, Dr Ruth KMPfau Civil Hospital, Karachi Pakistan, from Apr to Sep 2021.

Methodology: Sixty patients were divided as Z-plasty and square flap groups. The length of the contracture zone was measured. Z-plasty was performed to improve the functional and cosmetic appearance of the scar. A square flap was made to release the contracture. Splintage was maintained for two weeks after its release.

Results: The mean contracture length three weeks after Z-plasty release was 7.12 ± 4.14 cm and 15.39 ± 4.66 cm in square flap. Significant mean differences among techniques were observed among contracture length ($p=0.001$) and gain in length ($p=0.001$). The cubital fossa was the most common region treated with Z-plasty, while the finger was the most common region treated with square flap. The results showed a highly significant association of regions with respect to surgical techniques ($p=0.001$). An insignificant association was observed between gender ($p=0.436$) and cause of burn ($p=0.136$).

Conclusion: The square flap technique provides greater length gains than a Z-plasty technique.

Keywords: Gain in length, Post burn contracture Release, Square Flap, Z-plasty

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INTRODUCTION

Worldwide, the leading cause of morbidity and mortality is burn injuries. Due to fire-related burns, about 322,000 people died in 2002 around the globe. An estimated 10 million cases of fire burn-related disabilities leading to morbid lifestyles are reported annually.¹ Most of the burn injuries have been reported in low- and middle-income countries, with men being more commonly affected in the younger age group (0-12 years) and women being more affected after adolescence.² Burns and burns are the two most common causes. Electrical damage is more common in men, although it generally affects children and females.³ Disabilities resulting from burn injuries may have a lifelong impact on an individual.⁴

According to McCauley's severity score of burn contracture, Grade-1 and Grade-2 contractures can be managed with treatment. However, Grades 3 and 4, further classified as flexion, extension, or mixed deformity, are more complex.⁵ Reconstruction is necessary, along with the release of contracted skin and the covering of soft tissue defects, as well as secondary changes to muscle-tendon units, ligaments,

and joints, which must also be addressed.⁶ Choosing an appropriate surgical procedure is important to ensure the best functional outcome. The gold standard to resurface the defect resulting from the release of post-burn contracture is to mobilize the adjacent skin flaps, thus minimizing the differences in skin characteristics. However, the effectiveness of this method may be limited by factors such as the size of the area involved and the availability of non-scarred tissue for use as a skin flap.⁷ These methods are particularly effective in reconstructing burn contractures, extremities and trunk to maintain ROM throughout the joints. In addition to releasing contractures, rearrangement of local tissue has the advantage of lengthening and transposing scars. These locally dislocated flaps include Z-plasty, YV plasty, W-plasty, five or 4-flap plasty, and square flap. Z-plasty is a traditional procedure and is a reliable way to destroy the linear contracture zone, increase its length, and restore the normal range of motion of the joint.^{8,9}

The square flap technique was introduced by Hyakusoku and Fumiiri and is considered the best approach to correct post-burn contractures in many anatomical locations such as the axilla, antecubital fossa, neck, digital contractures, perineum, and popliteal fossa.¹⁰ The purpose of the current study is to compare postoperative length gain after burn

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contracture with a simple z-plasty and a square flap. This study will help the clinician to evaluate the release of the contracted skin and soft tissue defect coverage; the surgeon should pay attention to secondary changes in the musculotendinous unit, ligaments and joints. For the best functional patient outcome, suitable procedures should be adopted.

METHODOLOGY

This case series study was conducted at the Plastic and Reconstructive Surgery Department, Dr Ruth KMPfau Civil Hospital, Karachi, Pakistan from April to September 2021 after obtaining approval from the Institutional Ethical Review Committee (ref: IRB 1852/DUHS/approval/2021).

Inclusion Criteria: Study included male and female patients aged five years to 40 years with supple joints, linear contracture zones, and surrounding intact skin or axillary, cubital, popliteal, and finger contractures.

Exclusion Criteria: Patients with deep burns, joint contractures, scarring of the surrounding skin, widespread and irregular contractures or contractures of the neck, perineum, wrists or toes were not included.

All patients who met the inclusion criteria presented in the Plastic and Reconstructive Surgery department, Dr Ruth KM Pfau Civil Hospital Karachi, were enrolled. Informed and written consent was obtained from patients after the benefits and potential risks of the study were explained. According to surgical technique, the patients were divided into two groups, i.e. Z-plasty (Group-A) and Square flap (Group-B).

Patient demographic details like age, gender, and occupation were collected. Contracturebands length is measured in centimetres in the preoperative period immediately after the surgery and 3 weeks post-release using either of the two techniques, i.e. Z-plasty or Square flap. The contracture of the burn scar was considered to be a thickening of the skin after a second or third-degree burn. When the skin burned, the skin around it began to tighten, leading to contracture and movement restriction around the damaged area.

Z-plasty was performed with a locally displaced flap to enhance the scars' functional and cosmetic appearance. It consisted of creating two triangular patches of the same size, which were moved. A square flap was made as the local dislocation flap used to release the contracture. A square was marked on one side of the contracture, and two triangles were marked

on the other; all flaps were the same length and transposed. Splintage was maintained for two weeks post-release. Physiotherapy was started in the early postoperative period to improve the joint range of motion. All the demographics, clinical investigation and pre- and post-contracture band length were noted on a predesigned proforma.

Data was analyzed using Statistical Package for the Social Sciences (SPSS) version 25.00 and MS Excel 2016 software. Mean±SD was calculated for continuous variables. Frequency and percentage were calculated for categorical variables. The chi-square test and t-test were used for inferential statistics. The *p* value of ≤ 0.05 was considered significant.

RESULTS

Patients included in the study had their contracture band length measured in centimetres at the preoperative period, immediately after the surgery and 3 weeks post-release of the two techniques, i.e. Z-plasty or square flap. The mean contracture length pre-release, after release and three weeks after release in the z-plasty technique were observed as 5.70±3.96cm, 7.20±4.17cm and 7.12±4.14cm, respectively, while in the square flap technique, these findings were observed as 12.40±4.34cm, 15.44±4.70cm and 15.39±4.66cm respectively. The results showed 33(55%) male and 27(45%) female patients. The occupation was reported as 5(8.3%) patients had their own business, 11(18.3%) patients were officers, 5(8.3%) of patients were teachers, 13(21.7%) patients were labor, and 26(43.3%) patients were student. Most the patients, 45(75%), had flame burns, while only 12(25%) had scald. The region of the burn was also observed, and it was noted that the burn was 18(30%) in the finger, 15(25%) in the axilla, 15(25%) in the cubital fossa, and 12(20%) in the popliteal. The detailed frequency distribution of patient demographics and clinical findings are presented in Table-I.

The results showed significant mean differences among Z-plasty and Square flap techniques with respect to age (*p*<0.001), contracture length pre-release (*p*<0.001), contracture length after release (*p*<0.001), contracture length three weeks after release (*p*<0.001) and gain in length (*p*<0.001). There is an insignificant mean difference between Z-plasty and Square flap with respect to duration of injury (*p*=0.331) and follow-up time (*p*=0.570). The detailed results of the comparison of mean differences in clinical findings with respect to surgical techniques are presented in Table-II.

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Table-I. Descriptive Statistics of Demographics of Patients (n=60)

Variables	n (%)
Age Groups	
≤20 years	30(50)
>20 years	30(50)
Gender	
Male	33(55)
Female	27(45)
Occupation	
Businessman	5(8.3)
Officer	11(18.3)
Teacher	5(8.3)
Labor	13(21.7)
Student	26(43.3)
Cause of Burn	
Flame	45(75)
Scald	15(25)
Region	
Finger	18(30)
Axilla	15(25)
Cubital Fossa	15(25)
Popliteal Fossa	12(20)

Table-III: Association of Demographics and Clinical Findings with Surgical Techniques (n=60)

Variables	Z-Plasty	Square Flap	p-value
Age group			
≤20 years	24(80)	6(20)	<0.001*
>20 years	6(20)	24(80)	
Gender			
Male	15(50)	18(60)	0.436**
Female	15(50)	12(40)	
Occupation			
Businessman	0(0)	5(16.7)	<0.001*
Officer	3(10)	8(26.7)	
Teacher	0(0)	5(16.7)	
Labor	6(20)	7(23.3)	
Student	21(70)	5(16.7)	
Cause of Burn			
Flame	20(66.7)	25(83.3)	0.136**
Scald	10(33.3)	5(16.7)	
Region			
Finger	3(10)	12(40)	<0.001*
Axilla	6(20)	9(30)	
Cubital Fossa	18(60)	0(0)	
Popliteal Fossa	3(10)	9(30)	

Table-II. Mean comparison of Clinical Findings with respect to Surgical Techniques (n=60)

Clinical Findings	Z-Plasty	Square Flap	p-value
Age	13.20±8.04	28.90±9.80	<0.001*
Duration of injury	33.93±25.04	27.93±22.52	0.331**
Contracture length pre release	5.70±3.96	12.40±4.34	<0.001*
Contracture length after release	7.20±4.17	15.44±4.70	<0.001*
Contracture length 3 weeks after release	7.12±4.14	15.39±4.66	<0.001*
Gain in length	1.50±0.32	3.04±0.60	<0.001*
Follow up time	3.17±1.53	3.40±1.63	0.570**

It was observed that in Z-plasty, about 24(80%) patients belonged to age ≤ 20 years and in square flap, 24(80%) patients had age > 20 years. Most of the patients, 20(70%), were students, followed by labourers who were treated with the z-plasty technique, while in the square flap technique, most of the patients were officers, followed by labourers who were treated with the Square flap technique. It was also observed that both the flame burn and scald patients were treated in both technique groups. The cubital fossa was the most common region treated with z-plasty, while the finger was the most common region treated with square flap. All the demographic and clinical factors were associated with techniques using the chi-square test. The results showed a highly significant association of age group, occupation and region ($p < 0.001$) with respect to surgical techniques. An insignificant association was observed with gender ($p = 0.436$) and cause of burn ($p = 0.136$) among the study techniques. The detailed results of the association of techniques with the demographic and clinical factors are presented in Table-III.

DISCUSSION

Injuries in lower-middle-income countries are a common source of injury when wound care is insufficient; deep burns usually cause massive fibrosis affecting the deeper layer of the skin. This fibrosis of the joint causes significant contracture, negatively affecting its function. Moreover, the different growth rates of the burn scar and surrounding normal skin, especially in children, have a major and essential role in contractured development.¹¹ Once the contracture is fully established, surgery is inevitable to maintain function. Despite advances in the treatment of acute burns, contractures, which manifest as late burn complications, remain a problem for plastic surgeons.¹² The literature describes many methods for surgical treatment of contractures. Local flaps have been reported to be useful in treating linear contractures when the surrounding skin is normal.¹³ Z-plasty flap is the most frequent local flap for such

contractures. In addition to Z-plasty of flaps, the literature describes variants of YV-plasty, X-plasty, square flaps and subcutaneous rhomboid pedicle flaps.¹⁴

In the current study, we compare the mean differences in the increase in length after post-burn contracture removal with z-plasty and a square flap. One large Z-plasty shows reliable stretch, but larger flaps are subject to extra lateral tension.

Among the various local flap techniques currently in use, the square flap technique fits best for reconstructing the spider web with scar joint contracture, thereby converting the spider web to a web space. A three-flap Z-plasty, combining a square anterior flap with two triangular dislocation flaps, is transformed into a deep and wide complication that closely mimics the original structure of the square flaps.¹⁵ After surgery, the centrally placed square flap provides a large, flexible floor for the arachnoid space. Therefore, its dimensions determine the width of the commissure. After surgery, two lateral triangular flaps form the sidewalls of the membranous space. Therefore, those dimensions determine the depth of adhesion. These features ensure that the commissure is U-shaped and deep enough to bend naturally on the flat surface of the palm, ensuring that the membrane looks and functions normally after cuticle flap surgery. There is also a slope on the back of the palm.¹⁶

Our study demonstrated that a square flap provides greater length gains than a Z-plasty flap. One study stated that the square flap technique was more effective than the one-, four-. Five-flap Z-plastys because it lengthens the original scar band by 2.825 times compared to a lengthening capacity of ≤ 2.239 times for all types.¹⁷ Ulkur *et al.*, found that a 7-flap plasty provided an average of 105% immediate lengthening after surgery.¹⁸ Literature reports many of the benefits of using a square flap to relieve contracture. Square flaps are usually between scar-covered burn flaps due to optimal length increase, potential for further extension, and higher length ratios compared to other Z-plasty. Create a large flap area for inserting the textured skin flaps. In addition, square flap technology is associated with minimal physiological stress, which means minimal reliance on deformation and adjacent skin sagging.^{19,20}

The square flap has been revealed to be a simple technique that is easy to duplicate. It breaks the line of contracture with a square forward flap that provides good elongation and sufficiently large blood vessels

and a flexible soft tissue flap between burned scar tissue. In addition, it is associated with good cosmetological results with long-term follow-up. The limitation of this study is the small number of patients. More cases and extended follow-up intervals are needed to confirm the reliability and effectiveness of the square flap technique for eliminating scar contractures in various anatomical areas.

CONCLUSION

A square flap technique provides greater length gain than a Z-plastic technique and is more effective.

Conflict of Interest: None

Authors Contribution

Following authors have made substantial contributions to the manuscript as under:

AN & FA: Data acquisition, data analysis, data interpretation, critical review, approval of the final version to be published.

HA&UBW: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

EN & MN: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

- Mathers CD, Bernard C, Iburg KM, Inoue M, Ma Fat D, Shibuya K, et al. Global burden of disease in 2002: data sources, methods and results. WHO Geneva; 2003.
- Iqbal T, Saaq M. The burnt child: an epidemiological profile and outcome. J Coll Physicians Surg Pak 2011 ; 21(11): 691-694.
- Ahuja RB, Dash JK, Shrivastava P. A comparative analysis of liquefied petroleum gas (LPG) and kerosene related burns. Burns 2011; 37(8): 1403-1410.
<https://doi.org/10.1016/j.burns.2011.03.014>
- Sarma BP. Epidemiology and man-days loss in burn injuries amongst workers in an oil industry. Burns 2001; 27(5): 475-480.
[https://doi.org/10.1016/s0305-4179\(00\)00157-1](https://doi.org/10.1016/s0305-4179(00)00157-1)
- Bhattacharya V, Purwar S, Joshi D, Kumar M, Mandal S, Chaudhuri GR, et al. Electrophysiological and histological changes in extrinsic muscles proximal to post burn contractures of hand. Burns 2011; 37(4): 692-697.
<https://doi.org/10.1016/j.burns.2011.01.020>
- Hayashida K, Akita S. Surgical treatment algorithms for post-burn contractures. Burns Trauma 2017; 5(1): 9-16.
<https://doi.org/10.1186/s2017-017-0074-z>
- Hove CR, Williams III EF, Rodgers BJ. Z-plasty: a concise review. Facial Plast Surg 2001; 17(04): 289-294.
<https://doi.org/10.1055/s-2001-18828>
- Altun S, Çakır F, Öztan M, Okur Mİ, Bal A. Do rhomboid flaps provide more elongation than Z-plasty flaps? An experimental study. J Plastic Surg Hand Surg 2018; 52(3): 148-152.
<https://doi.org/10.1080/2000656x.2017.1372287>

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9. Hyakusoku H, Fumiiri M. The square flap method. *British J Plastic Surg* 1987; 40(1):40-46. [https://doi.org/10.1016/0007-1226\(87\)90009-9](https://doi.org/10.1016/0007-1226(87)90009-9)
 10. Hifny MA. The square flap technique for burn contractures: clinical experience and analysis of length gain. *Ann Burns Fire Disasters* 2018 ; 31(4): 306-312.
 11. Karki D, Narayan RP. Role of square flap in post burn axillary contractures. *World J Plast Surg* 2017; 6(3): 285-291.
 12. Fernandez-Palacios J, Bayón PB, Sánchez OC, Duque OG. Multilevel release of an extended postburn contracture. *Burns* 2002; 28(5): 490-493. [https://doi.org/10.1016/s0305-4179\(01\)00120-6](https://doi.org/10.1016/s0305-4179(01)00120-6)
 13. Aslan G, Tuncali D, Cıgşar B, Barutcu AY, Terzioğlu A. The propeller flap for postburn elbow contractures. *Burns* 2006; 32(1): 112-115. <https://doi.org/10.1016/j.burns.2005.07.007>
 14. Baux S, Mimoun M, Kirsch JM, Zumer L, Berard V. Treatment of elbow contractures in burns. *Burns* 1987; 13(3): 241-244. [https://doi.org/10.1016/0305-4179\(87\)90175-6](https://doi.org/10.1016/0305-4179(87)90175-6)
 15. Lai CS, Lin SD, Tsai CC, Tsai CW. Running Y-V-plasty for burn scar contracture. *Burns* 1995; 21(6): 458-462. [https://doi.org/10.1016/0305-4179\(95\)00019-8](https://doi.org/10.1016/0305-4179(95)00019-8)
 16. Vartak A, Keswani MH. X-plasty for repair of burn contractures. *Burns* 1992; 18(4): 326-328. [https://doi.org/10.1016/0305-4179\(92\)90156-o](https://doi.org/10.1016/0305-4179(92)90156-o)
 17. Hyakusoku H, Fumiiri M. The square flap method. *British J Plastic Surg* 1987; 40(1): 40-46. [https://doi.org/10.1016/0007-1226\(87\)90009-9](https://doi.org/10.1016/0007-1226(87)90009-9)
 18. Ulkur E, Acikel C, Evinc R, Celikoz B. Use of rhomboid flap and double Z-plasty technique in the treatment of chronic postburn contractures. *Burns* 2006; 32(6): 765-769. <https://doi.org/10.1016/j.burns.2006.01.015>
 19. Ertas NM, Küçükçelebi A, Erbas O, Bozdogan N. Comparison of elongations provided by subcutaneous pedicle rhomboid flap and Z-plasty in rat inguinal skin. *Plast Reconstruct. Surg* 2006; 117(2): 486-90. <https://doi.org/10.1097/01.prs.0000197212.84348.db>
 20. Ostrowski DM, Feagin CA, Gould JS. A three-flap web-plasty for release of short congenital syndactyly and dorsal adduction contracture. *J Hand Surg* 1991; 16(4): 634-641. [https://doi.org/10.1016/0363-5023\(91\)90186-f](https://doi.org/10.1016/0363-5023(91)90186-f)
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