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Effectiveness of Post-Burn Finger Contracture Release with 5-Flap Z-Plasty without Graft

Zahida Younas, Shumaila Yousaf, Bushra Akram Mughal, Urwa Tanveer Ahmad, M Behram Abbas, Saqib Shakoor

Abstract

Objective: To determine the functional outcome of the 5-flap Z-plasty technique without skin graft in terms of mean improvement in extension lag angle in the surgical management of post-burn finger contractures.

Study Design and Setting: A prospective interventional study was conducted at Allied Burn and Reconstructive Surgery Centre Faisalabad, Pakistan, from august 2025 to February 2026.

Methodology: A total of 65 patients were enrolled. Patients of both genders with age ranging from 4 to 40 years were included that were having moderate degree of post burn finger contractures with pliable surrounding skin and supple interphalangeal joints. All patients underwent release of contracture using a 5-flap Z-plasty without a skin graft. Extension lag angle was measured pre-operatively and post-operatively using a standard goniometer.

Results: Of 65 patients, 37 (56.9%) were male and 28 (43.1%) were female, with a mean age of 15.75 ± 8.91 years. The mean pre-operative extension lag angle was 62.46 ± 12.25°, which decreased significantly to 1.08 ± 2.57° post-operatively ($p = 0.001$), yielding a mean improvement of 61.38 ± 10.84°. The mean improvement in extension lag angle was stable across subgroups, with no statistically significant differences by gender ($p = 0.159$) or age group ($p = 0.113$).

Conclusion: The 5-flap Z-plasty technique without skin graft achieves significant functional improvement in moderate degree post-burn finger contractures with good flap viability rates, no donor site morbidity, good colour match, start of early rehabilitation and no need for prolonged immobilization.

Key Words: Burn, Post-burn contracture; 5-Flap Z plasty, Contracture release

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INTRODUCTION

A burn injury is the coagulative destruction of the skin and its underlying tissue by thermal, chemical, electrical or mechanical energy.[1] post-burn complications range from local wound issues to systemic, life-threatening conditions resulting in long-term physiologic and psychological complications.[2]

Burn contracturesÊare the most common postburn complication and are present in 18-50% of all burn survivors. The severity of a burn contracture depends on several factors such as, location and depth of the burn, timing of surgical or nonsurgical treatment, post-injury splinting, hand physiotherapy and scar care during the maturation process.[3]

Post-burn finger contractures represent one of the most devastating complications of thermal injury, frequently leading to physical deformity of hand, post burn web creep, restriction of range of joint motion and hence affecting the ability to perform daily activities independently and overall quality of life (QoL). Physical deformities also lead to psychiatric issues like low self-esteem and social detachment Thus, an appropriate and timely surgical intervention followed by rehabilitation from hand therapist is mainstay of treatment to prevent complete joint ankylosis.[4]

Proximal inter-phalangeal joint PIPJ flexion contractures were classified by Stern et al. into three grades. In grade I, the contracture at the PIPJ is correctable by passive flexion of the MCPJ, is considered mild. In grade II, the PIPJ flexion contracture is partially correctable with passive MCPJ flexion and is referred as moderate degree. A grade III contracture is fixed at the PIPJ regardless of the position of the MCP and is considered the severe variety.[5]

Contracture release followed by coverage with split and full thickness skin grafts has long been the mainstay of both initial and secondary burn surgeries. Full thickness skin grafts are considered more efficient than split-thickness grafts. After reconstruction Kirschner wire immobilization is mandatory to maintain full extension during the soft tissue healing process. This graft-based reconstruction imparts significant challenges including graft loss, differences in color and texture, secondary graft contraction and joint stiffness due to prolonged immobilization.[6-8]

Locoregional flaps are surgical techniques used to release scar contractures by transposing rotating, or advancing adjacent, healthy tissue into the released area. They are preferred over skin grafts because they provide good color/texture match, have less risk of secondary contraction, and grow with the patient.[9]

Z-plasty, single/multiple is a common reconstructive surgical technique used for scar revision and contracture release. It involves the transposition of two opposing triangular flaps that then changes the direction of a scar. Multiple Z-plasties breaks a long scar into series of triangular flaps (forming a "zig-zag" pattern) that are transposed. Z-plasty is an excellent option for linear bands that are surrounded by healthy tissue to restore normal contour and to provide a good color match. But there are some limitations of this technique. As the degree of contracture and surrounding tissue scarring increases the chances of flap transposition decreases due to inelastic nature of scar, also chances of flap necrosis increases due to poor blood supply of scarred tissue.[10-12]

The five-flap Z-plasty, frequently referred to as the “Jumping Man Flap”, utilizes a central Y-to-V advancement flap between two opposing Z-plasties and provide approximately 125%gain in scar length while evenly distributing tension across various tissue vectors[12]. Recent comparative evidence has confirmed its superiority in finger web contractures, with five-flap Z-Plasty yielding a significant improvement in finger abduction angles (19° ± 4°) compared to double z-plasty. Analysis of post-burn contracture release has shown that five-flap Z-plasty has mechanical effectiveness across various anatomical sites.[13]

Trapeze flap, square flap and cross finger flap are some other reconstructive options for coverage of defect after contracture release; however, each technique has its limitations and drawbacks.[14-15]

Moderate and severe degree of contractures pose a significant challenge and cannot be released with multiple z-plasty without incorporating skin graft.[5] The rationale of the present study is to address the paucity of evidence regarding the effectiveness of the 5-flap Z-plasty technique without adjunctive skin grafting in terms of mean improvement in extension lag angle, in the management of moderate-degree post-burn finger contractures. The 5-flap technique offers a compelling alternative that avoids prolonged Kirschner wire immobilization, enables early rehabilitation, and facilitates an earlier return to normal daily activities.

METHODOLOGY

A prospective interventional (pre-post) study was conducted at Allied Burn and Reconstructive Surgery Centre, Allied Hospital, Faisalabad, Pakistan, over a period of 15 August 2025 to 15 February 2026.

Ethical approval was obtained from the Institutional Ethical Review Committee with Reference number 48 ERC/FMU2025-26-124, Allied Hospital, Faisalabad, and the College of Physicians and Surgeons Pakistan (CPSP) before commencement of the study. Written informed consent was obtained from all adults and parents/guardians for pediatric patients.

A total of 65 patients were enrolled using consecutive sampling. Sample size was calculated using the WHO single-mean calculator, based on a population mean ± SD of 19 ± 4 degrees, a 95% confidence interval, and a margin of error of 1, yielding a minimum sample size of 65.[13]

Inclusion criteria comprised patients of both genders age ranging from 4 to 40 years with post-burn linear band type soft tissue finger contracture, pliable surrounding skin, supple joints, and moderate degree of contracture. Exclusion criteria were post-electric burn contracture, ankylosed joints, surrounding scarred skin, and previously operated cases.

Pre-operative assessment included documentation of demographics, hand dominance, duration of contracture, number of fingers involved, degree of scarring, and pre-operative extension lag angle measured using a standard goniometer. All patients underwent contracture release with 5-flap Z-plasty without skin graft under local or general anesthesia as determined by patient factors. Hemostasis was secured, and wounds were closed.

Dressing was changed on the first postoperative day to assess flap viability. Patients were discharged on 2nd postoperative day and reviewed weekly for one month, then fortnightly for three months. At each visit, wound healing, post-operative extension lag, and complications were recorded. Sutures were removed at 10–14 days. All patients were referred to a physiotherapist for physiotherapy after suture removal. Improvement in extension lag angle was calculated as the difference between pre- and post-operative values at 3 months. Data were recorded on a structured proforma.

Data were analyzed using SPSS version 25.0 (IBM Corp.,

Armonk, NY, USA). Quantitative variables (age, duration of contracture, pre- and post-operative extension lag angle, and improvement in extension lag angle) were expressed as mean ± standard deviation. Categorical variables (gender, mode of burn, involved digits, K-wire usage) were reported as frequencies and percentages. Paired samples t-test was applied to compare pre- and post-operative extension lag angles. Effect modifiers (age group, gender, number of digits) were controlled by stratification. Post-stratification, an independent samples test was applied to assess their effect on the outcome. A p-value of =0.05 was considered statistically significant.

RESULTS

A total of 65 patients were recruited in this study. There was slight male predominance 37(56.9%) than female 28(43.1%). Pediatric patients of 4-14 years and adults of 15-40 years age groups were 33(50.8%) vs.32(49.2%,) respectively, with mean age 15.75 ± 8.91 years. The mean contracture duration was 2.98 ± 2.41 years. Dominant hand was involved in 34 (52.3%) cases. Scald burns were observed in substantial proportion (55.4%), followed by flame burns (41.5%), and contact burns (3.1%). K-wire fixation was employed in 21.5% of patients. Multiple digits were involved in comparatively higher number of patients (52.3%) than single digit (47.7%) while only 30.8% patients demonstrated superficial necrosis (Table 1). Regarding involved digits, index finger was the most common digit involved (21.5%), followed by the little finger (15.4%). Isolated thumb and ring finger involved in 4.6% of study cohort while the middle finger was involved only in 1.5% of cases. Involvement of adjacent digits such as middle and ring finger together or ring with little finger together was observed in 15.4% and 12.3% of cases respectively. However, combined involvement of three digits was observed only in 3.1% of patients (Table 2).

The comparison of pre-operative and post-operative extension lag angles demonstrated a significant improvement from pre-operative extension lag angle (62.46 ± 12.25°) to post-operative extension lag angle (1.08 ± 2.57°) with mean improvement in extension lag angle of 60.82±11 with a statistically significant p-value (0.001), highlighting improved digital extension (Table 3). Female patients exhibited slightly higher mean improvement in extension lag angles (63.57 ± 10.17°) as compared to males (59.73 ±11.17°). However, this difference was not statistically significant (p = 0.159). Pediatric patients achieved slightly higher mean improvement (63.47 ± 8.96°) as compared to adults (59.22 ± 12.25°), with no statistically significant difference across age groups (p= 0.113). Patients with single affected digit demonstrated higher mean improvement of extension lag angles (62.90 ± 7.72°) in comparison to those with multiple digits involved (60.00 ± 13.02°) with difference not statistically significant p = 0.284(Table 4) There were no cases of complete flap necrosis, only superficial flap tip necrosis was found that was managed conservatively, indicating a highly satisfactory surgical outcome. None of the patients required subsequent skin grafting and revision surgery.

Table I: Baseline demographic and clinical characteristics (n=65).

Variable	Category	n (%) / Mean ± SD
Gender	Male	37 (56.9%)
	Female	28 (43.1%)
Age (years)	Mean ± SD	15.75 ± 8.91
Age group	Pediatric (4–14 yrs)	33 (50.8%)
	Adult (15–40 yrs)	32 (49.2%)
Duration of contracture (years)	Mean ± SD	2.98 ± 2.41
Dominant hand involvement	Yes	34 (52.3%)
Mode of burn	Scald	36 (55.4%)
	Flame	27 (41.5%)
	Contact	2 (3.1%)
K-wire immobilization	Yes	14 (21.5%)
	No	51 (78.5%)
Number of involved digits	Single	31 (47.7%)
	Multiple	34 (52.3%)
Necrosis	Yes	20 (30.8%)
	No	45(69.2%)

Table 2: Distribution of involved finger(s) (n=65).

Finger(s) Involved	N	%
Thumb	3	4.6
Index	14	21.5
Middle	1	1.5
Ring	3	4.6
Little	10	15.4
Middle + Ring	10	15.4
Index + Middle	5	7.7
Ring + Little	8	12.3
Thumb + Index	6	9.2
Index + Middle + Ring	2	3.1
Thumb + Little	3	4.6
Total	65	100.0

Table 3: Pre-operative, post-operative and improvement in extension lag angle (n=65)

Variable	Mean ± SD (degrees)	CI (95%)	p-value
Pre-operative extension lag angle	62.46 ± 12.25	58.70-45.65	0.001
Post-operative extension lag angle	1.08 ± 2.57		
Mean improvement in extension lag angle	60.82±11		

Table 4: Effect of modifiers on improvement in extension lag angle (post-stratification independent samples t-test)

Variable	Category	Mean Improvement ± SD (°)	p-value
Gender	Male (n=37)	59.73 ± 11.17	0.159
	Female (n=28)	63.57 ± 10.17	
Age group	Pediatric (n=33)	63.48 ± 8.96	0.113
	Adult (n=32)	59.22 ± 12.25	
Number of digits	Single (n=31)	62.90 ± 7.72	0.284
	Multiple (n=34)	60.00 ± 13.02	

Figure 1: Pre-operative image of 23 yr/ F with post burn thumb contracture having pre-operative extension lag of 55° showing marking of 5-flap Z-plasty

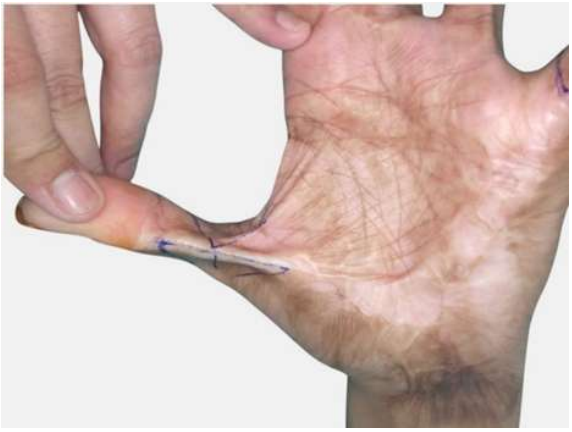

Figure 2: Immediate post-operative image demonstrating complete release with 0°post operative extension lag

Figure 3: Post operative image demonstrating wound healing, complete contracture release having no extension lag, good color match to surrounding skin and scar characteristics.

DISCUSSION

The present study shows that five-flap Z-plasty without skin grafting is an extremely effective method of correcting post-burn finger contractures of moderate degree. In a group of 65 patients, the mean extension lag angle reduced from 62.46°±12.25 preoperatively to 1.08°±2.57 postoperatively, indicating nearly complete restoration of digital extension. This level of correction is consistent with the biomechanical basis of the five-flap technique, which includes a central Y-V advancement flap between two opposing Z-plasties to get greater longitudinal lengthening than conventional designs.[16] The lack of total flap necrosis, as well as the absence of the need for secondary skin grafting or revision surgery, lends credence to the reliability and efficacy of this reconstructive method as a stand-alone therapy option for digital burn contractures. The positive effects indicate that the treatment provides sufficient vascularity, consistent wound healing, and effective tissue repair without requiring further corrective techniques. Moreover, the removal of secondary procedures reduces patient morbidity, shortens recovery time, lowers healthcare costs, and enhances overall functional and aesthetic outcomes. The flap's persistent viability demonstrates the technical safety and resilience of the reconstructive technique for managing post-burn digital deformities and contractures. Overall, these findings support the surgical technique's function as a reliable and feasible choice for reconstructing moderate degree post burn contractures.

Yang et al. found that five-flap Z-plasty improved abduction angle by 19° ± 4°, outperforming double Z-plasty by 12° ± 2°, and corrected web slope more effectively.[13] Our study supports these findings by confirming that when applied to finger contractures without adjunctive grafting, five-flap Z-plasty provides more functional restoration than multiple Z-plasty while avoiding donor-site complications.

The avoidance of skin grafting provides a significant advantage in digital reconstruction. Traditional contracture release has commonly relied on split-thickness or full-thickness skin graft coverage. However, graft-based techniques are associated with graft loss, color and texture mismatch, secondary contraction, and donor-site morbidity.[11] Alsaif et al. conducted a systematic review and meta-analysis and found that, while full-thickness skin graft provide better results than split-thickness skin graft, both modalities are susceptible to suboptimal aesthetic and functional outcomes.[7]

In this study, the use of local flaps eliminated the requirement for graft harvest completely in moderate degree of finger contractures, and no patient needed secondary grafting. This is consistent with the larger shift toward flap-based reconstruction in post-burn hand surgery, as vascularized tissue not only provides superior pliability but also reduces the risk of secondary contraction when compared to graft.[16] The present study's demographic profile revealed a slight male predominance, a mean age of 15.75 years, and scald burns as the leading etiology, which is consistent with recent epidemiological descriptions of hand and finger contractures in post-burn populations,Êwhich consistently report male predominance, high incidence in pediatric age groups, and scald burns as a common cause[17-18]. Particularly, we found no significant differences in outcomes by gender, age group, or whether single or multiple digits were involved. This indicates that five-flap Z-plasty is widely applicable in both pediatric and adult populations, as well as at varying levels of digital involvement. The finding that pediatric patients achieved marginally greater improvement than adults, although without statistical significance, is consistent with the known plasticity of pediatric tissue and the potential for stronger remodeling in younger patients.

This study's complication profile emphasizes the safety of this method. Superficial flap tip necrosis was found with no case of complete flap necrosis, the results are comparable to those reported in recent large series of local flap reconstruction for burn contractures. A study reported a 10.8% overall complication rate among 243 patients undergoing local flap reconstruction for post-burn contractures of the extremities and neck, with re-contracture occurring in 3.8% and flap tip necrosis in 1.3%.[19] When compared with loco-regional flaps, 5-flap Z plasty provides several benefits for post burn finger contractures. The keystone flap works well for wide, oval-shaped wounds but depends on healthy surrounding tissue. In burned fingers, there is extensive scarring leading to compromised blood supply at flap base, making the flap less reliable.[14] The five-flap Z-plasty is random pattern flap and can be used even in moderately scarred skin. The square flap is good for releasing contractures in the web spaces between fingers, but it is not designed for linear bands on the front (volar) surface of a finger[20]. The five-flap Z-plasty works better for linear band like contractures along the finger. The trapeze flap gives good long-term results, but it needs a broad base of healthy skin. On a burned finger, there may not be enough unscarred tissue.[15] The five-flap Z-plasty effectively utilizes lateral skin expansion around the scar, making it more practical. Strengths of this study were found to be due to the geometry of five-flap Z-Plasty without skin grafting to release post burn moderate degree of finger contractures. Followed by another strength of this study is the generalizability is increased by encompassing both pediatric and adult patients in the present study. The standardized post-surgical rehabilitation protocol, which includes physiotherapy for all study participants after removal of sutures, ensures that the stated findings are a result of the surgical technique and not of differences in rehabilitation. Objective goniometric measurement of extension lag angles provides measurable evidence of functional recovery in patients.

Limitations: There are various limitations to this present study that require to be considered. First of all, small sample size and single center study limit the generalizability to broader segments of the population with multiple demographic and clinical characteristics of the population. The follow-up duration was limited to only 3 months after surgical procedure, which did not enable researchers to analyze the long-term functional effects, recurrence of the contracture, and long-lasting sustainability of the surgical therapy. The lack of a comparison group undergoing other surgical techniques (e.g., grafting of the skin and convention Z-plasty) limits the ability to directly compare the efficacy of the five-flap Z-plasty techniques with previous surgical procedures. Lastly, findings were assessed only by objective goniometric measurements of extension lag angle, removing reports of patient's findings measures, functional scoring systems, and quality of life (QoL) indicators that would allow more comprehensive assessment of surgical success from the perspective of the patient.

CONCLUSION

The study found that surgical release of post-burn finger flexion contractures with 5-flap Z-plasty technique yielded good functional outcomes with minimal complications. The technique restored near-complete finger extension in all patients, irrespective of gender, age, or number of digital involvement. In particular, the technique is highly effective for moderate degrees of contracture with surrounding lateral skin expansion and supple joints. These contractures are less likely to be released with multiple z-plasty without incorporating skin graft. This technique's superiority can be attributed to the use of the 5-flap Z-plasty, which provides up to 125% of length gain, compared with roughly 75% with standard Z-plasty. The high rate of flap viability and the absence of total necrosis illustrate the technique's reliability. Furthermore, the low rate of wound complications, like flap tip necrosis, all minor and managed conservatively, contributes to its safety profile. The standardized initiation of physiotherapy following suture removal on 10-14th post-operative day most certainly contributed to the positive functional outcomes. K-wiring was done only in 14(21.5%) cases for 10-14 days to break joint memory, mostly in pediatric population where compliance to external splintage was a problem. None of the examined modifiers (age, gender and number of fingers involved) had a significant impact on recovery, demonstrating consistent results across patient groups. The surgical strategy is an effective solution for post burn moderate degree digital flexion contractures particularly

in conditions where conventional Z-Plasty will not release contracture completely without incorporating graft. It also avoids prolonged immobilization with K-wiring and results in early recovery, with good color and texture match. All this leads to start of early rehabilitation by hand therapist and back to their daily life activities by patient.

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Bushra Akram Mughal: Introduction and Methodology.
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