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Original Research

OUTCOMES OF Z-PLASTY SURGERY IN FUNCTIONAL RESTORATION OF CONTRACTED FINGERS

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ABSTRACT: Finger contractures, resulting from burns, trauma, or congenital anomalies, often lead to significant functional impairment. Z-plasty is a versatile reconstructive technique used to release scar contractures while preserving local tissue characteristics. This study aimed to evaluate the functional outcomes of different Z-plasty techniques in the surgical release of contracted fingers. We conducted a prospective descriptive case series involving 31 patients (38 fingers) undergoing Z-plasty for digital contractures. Depending on the location and severity of the contracture, three Z-plasty techniques were used: five-flap, double-opposing, and single 60° Z-plasty. Patients were followed for a mean of 5.6 months. Primary outcomes included range of motion (ROM), web space angle, and DASH scores. Complications and patient satisfaction (VAS) were also assessed. All techniques demonstrated significant improvements in finger extension and flexion. Mean extension deficit improved from −35.4° to −8.1°, and flexion increased from 62.3° to 81.7° ($P < .001$). The five-flap Z-plasty achieved the greatest gain in web space angle (from 24.2° to 46.8°). DASH scores decreased significantly from 47.6 to 21.8 ($P < .001$), with patient satisfaction increasing from 4.2 to 8.1 on VAS. Minor complications occurred in 5 patients (16.1%), with no cases of flap necrosis or wound infection. Z-plasty is an effective and low-risk technique for releasing digital contractures and restoring hand function. Five-flap and double-opposing Z-plasty provide greater functional improvement in web space contractures, while single Z-plasty remains effective for linear joint contractures. These techniques offer reliable outcomes without the need for skin grafting, supporting their continued use in reconstructive hand surgery

Keywords: Z-plasty, finger contracture, five-flap Z-plasty, web space release, functional outcome, scar revision, hand surgery

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1. INTRODUCTION

Contracture of the fingers is a common sequela following burn injury, trauma, or prolonged immobilization, often resulting in significant functional impairment of hand movement, including grip, pinch, and fine motor tasks. These contractures can affect one or multiple joints and may involve the skin, subcutaneous tissues, and deeper structures such as tendons and joint capsules. Restoration of finger extension and hand function remains a surgical challenge, especially when the contracture involves the interphalangeal joints or web spaces.

Z-plasty is a versatile local flap technique widely used to release linear contractures by lengthening scarred tissues and reorienting tension lines. It is particularly effective in the management of contractures of the fingers, palm, and first web space, offering the advantages of improved mobility, tension redistribution, and preservation of local skin texture and pigmentation. The basic principle involves transposition of triangular flaps to gain length along the axis of the contracture while minimizing donor site morbidity. Several variations have been developed to maximize gain in length, including four-flap, five-flap (jumping man), and double-opposing Z-plasties.1–3

The five-flap Z-plasty, combining two opposing Z-plasties with an additional Y-V advancement flap, offers greater tissue lengthening and web space deepening compared to other techniques. It is particularly favored in the correction of first web space and interdigital contractures due to its geometric efficiency and improved postoperative function.4–6 Recent reports support its efficacy in both congenital and acquired contractures of the hand, with acceptable cosmetic outcomes and low complication rates.7–9 Nevertheless, there remains a paucity of prospective data specifically evaluating the functional outcomes of Z-plasty in digital contracture release in adult populations across varying etiologies.

In this study, we aimed to evaluate the outcomes of Z-plasty surgery in the functional restoration of contracted fingers through a prospective descriptive case series of 31 patients. By documenting the preoperative presentation, surgical technique, and postoperative outcomes, we seek to contribute further clinical evidence to support the role of Z-plasty in hand reconstructive surgery and guide its application in routine practice.

2. METHODS

2.1. Study Design and Setting

This study was designed as a prospective descriptive case series and conducted at Thong Nhat Hospital between January 2022 and January 2026. The study protocol was approved by the Institutional Review Board (IRB) of Thong Nhat Hospital, and all participants provided written informed consent prior to enrollment.

2.2. Patient Selection

A total of 31 patients with finger contractures of various etiologies were recruited consecutively. Inclusion criteria were: (1) presence of functional limitation due to flexion or web space contracture of one or more fingers; (2) indication for surgical release using Z-plasty; (3) age ≥18 years; and (4) willingness to comply with postoperative follow-up. Exclusion criteria included: (1) active infection at the surgical site, (2) uncontrolled comorbidities contraindicating surgery, and (3) previous local flap surgery in the affected area.

2.3. Preoperative Assessment

All patients underwent detailed clinical evaluation, including range of motion (ROM) assessment of the affected joints using a goniometer and grading of contracture severity. Functional limitation was assessed using the Disabilities of the Arm, Shoulder and Hand (DASH) score and a visual analogue scale (VAS) for functional impairment (0–10).

2.4. Surgical Technique

All procedures were performed under regional or general anesthesia with tourniquet control. The type of Z-plasty performed (e.g., classic 60° single Z-plasty, double-opposing Z-plasty, or five-flap Z-plasty) was determined based on contracture location, severity, and local skin laxity. The limbs of the Z-plasty were marked with a 60° angle in most cases to maximize length gain. For first web space contractures, the five-flap Z-plasty was preferred due to its superior lengthening

effect.6,7

Following contracture release and flap transposition, meticulous hemostasis was achieved, and the flaps were sutured with 5-0 nylon. A soft bulky dressing and volar splint were applied with the fingers in extension. No skin grafts were used in this cohort.

2.5. Postoperative Care and Rehabilitation

Patients were followed postoperatively at 1 week, 1 month, 3 months, and 6 months. At 1 week, sutures were removed, and physiotherapy was initiated focusing on passive and active ROM exercises. Night splinting was continued for 6–8 weeks. Adherence to physiotherapy was monitored.

2.6. Outcome Measures

Primary outcomes included improvement in passive and active range of motion (degrees) and web space angle (if applicable). Secondary outcomes were changes in DASH score, patient satisfaction via VAS (0–10), and complications such as flap necrosis, infection, or recurrence of contracture.

Data were collected prospectively using a standardized form and entered into a secured database for analysis.

3. RESULTS

3.1. Patient Characteristics

A total of 31 patients (18 males and 13 females) with a mean age of 35.8 years (range, 19–62 years) were included. The most common etiology of contracture was post-burn scar (n=22, 71.0%), followed by traumatic scar contracture (n=6, 19.4%) and congenital web syndactyly or postoperative adhesions (n=3, 9.6%). A total of 38 fingers were operated on (some patients had multiple digits involved) (Table 1).

Contractures were distributed as follows:

- First web space: 12 cases (31.6%)
- Second to fourth interdigital spaces: 9 cases (23.7%)
- Flexion contracture of proximal or distal interphalangeal joints: 17 cases (44.7%)

3.2. Surgical Technique Used

- Five-flap Z-plasty: 14 cases (45.2%)
- Double-opposing Z-plasty: 11 cases (35.5%)
- Classic single Z-plasty: 6 cases (19.3%)

All procedures were completed without intraoperative complications. No cases required skin grafting.

Table 1. Patient Distribution and Type of Z-Plasty Technique Used (n = 31 patients, 38 fingers)

Type of Z-Plasty	Number of Fingers (%)	Location
Five-flap Z-plasty	14 (36.8%)	Mostly first web space, deep contractures
Double-opposing Z-plasty	11 (28.9%)	Interdigital spaces (2nd–4th)
Single Z-plasty (60°)	13 (34.2%)	PIP/DIP joint flexion contractures
Total	38 (100%)	

3.3. Functional Outcomes

At the final follow-up (mean: 5.6 months; range: 4–8 months), there was a statistically significant improvement in finger range of motion (Table 2):

The mean follow-up duration was 5.9 months for five-flap Z-plasty, 5.4 months for double-opposing Z-plasty, and 5.3 months for single Z-plasty.

Mean active extension deficit improved from −35.4° preoperatively to −8.1° postoperatively ($P < .001$)

Mean active flexion improved from 62.3° to 81.7° ($P < .01$)

For web space contractures, mean web space angle increased from 23.5° to 44.2°, restoring functional abduction ($P < .001$)

Table 2. Comparison of Range of Motion (ROM) and Web Space Angle Pre- and Postoperatively by Z-Plasty Technique

Z-Plasty Type	Site Treated	Pre-op Extension Deficit (°)	Post-op Extension Deficit (°)	Pre-op Flexion (°)	Post-op Flexion (°)	Web Angle Pre-op (°)*	Web Angle Post-op (°)*
Five-flap Z-plasty	First web space (n=14)	–12.1 ± 6.2	–2.5 ± 2.3	65.3 ± 10.5	83.4 ± 8.1	24.2 ± 5.4	46.8 ± 6.3
Double-opposing Z-plasty	2nd–4th web spaces (n=11)	–15.3 ± 7.1	–4.6 ± 3.4	63.2 ± 9.4	79.2 ± 7.5	22.9 ± 4.6	42.5 ± 5.9

*Web angle = angle between thumb and index finger (or adjacent fingers) in abducted position.

The DASH score improved from a preoperative mean of 47.6 ± 9.2 to a postoperative mean of 21.8 ± 7.6 (P < .001).

Patient-reported satisfaction (VAS score, 0–10) increased from a mean of 4.2 preoperatively to 8.1 postoperatively (Table 3).

In addition to improved DASH scores, most patients reported greater ease in performing daily activities such as dressing, hygiene, and object manipulation by the third postoperative month.

Table 3. Functional Scores and Patient-Reported Outcomes

Outcome Measure	Preoperative Mean ± SD	Postoperative Mean ± SD	P-value
DASH Score	47.6 ± 9.2	21.8 ± 7.6	< 0.001
Patient Satisfaction (VAS 0–10)	4.2 ± 1.4	8.1 ± 1.2	< 0.001

3.4. Complications

There were no cases of complete flap necrosis. Minor complications included:

Superficial epidermolysis in 2 cases (6.5%), resolved conservatively

Mild hypertrophic scarring in 3 cases (9.7%)

Recurrent minor contracture in 2 cases (6.5%) after 4–5 months, both managed conservatively with physiotherapy and night splinting

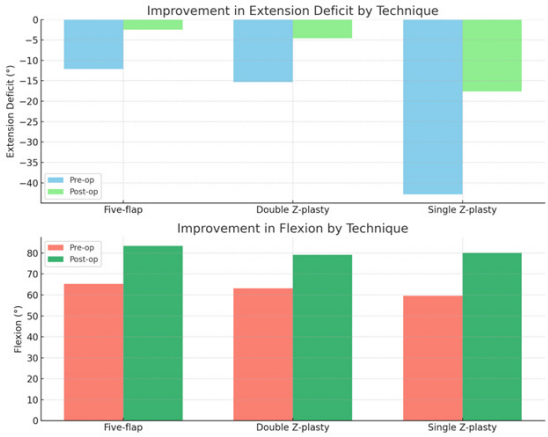

Figure 1. Improvement in Extension Deficit and Flexion Following Different Surgical Techniques

No wound infections, neurovascular injuries, or need for revision surgery were observed during the follow-up period (Table 4).

Table 4. Postoperative Complications (n = 31 patients)

Complication	Number of Patients (%)
Superficial flap epidermolysis	2 (6.5%)
Mild hypertrophic scar	3 (9.7%)
Minor recurrent contracture	2 (6.5%)
Flap necrosis	0 (0%)
Wound infection	0 (0%)
Neurovascular injury	0 (0%)

4. DISCUSSION

The results of this prospective case series support the efficacy of Z-plasty techniques in the surgical release of finger contractures across various anatomical locations and etiologies. All three techniques used in our study—five-flap Z-plasty, double-opposing Z-plasty, and classic single Z-plasty—showed statistically significant improvement in both extension and flexion range of motion (ROM), with minimal complication rates and high patient satisfaction.

The five-flap Z-plasty demonstrated the greatest improvement in web space abduction and flexion gain, particularly in first web space contractures. This is consistent with previous studies indicating that the five-flap design provides a more substantial gain in length than other forms of Z-plasty while preserving tissue vascularity and minimizing tension along the closure line.4,5 Rogers et al. have shown that the five-flap ("jumping man") technique can effectively increase the web space length by up to 125%, making it highly suitable for deep and resistant contractures of the thumb-index commissure.5

Double-opposing Z-plasty also yielded favorable outcomes in our cohort, particularly in second to fourth interdigital contractures. Its symmetrical design facilitates balanced tension release and improves the contour of the interdigital web. This is in agreement with previous literature supporting its application in cleft, axillary, and digital reconstructions.3,6

The single 60° Z-plasty technique, while less complex, was effectively applied in flexion contractures of the PIP and DIP joints. Despite being used in more severe contractures preoperatively (mean extension deficit −42.8°), the single Z-plasty achieved a meaningful correction of extension deficit and restoration of functional flexion, consistent with the classical geometric lengthening described in foundational plastic surgery texts.1,2

Functionally, the improvement in DASH scores and subjective VAS satisfaction ratings in all groups reflects meaningful restoration of hand use in daily activities. The mean DASH score decreased from 47.6 to 21.8, exceeding the minimal clinically important difference (MCID) reported in upper limb literature. This aligns with studies indicating that localized flap-based release, especially Z-plasty, provides functional improvement with low morbidity in hand contracture surgery.3,7

Our complication rate was low, with no major surgical morbidity. Minor superficial epidermolysis and hypertrophic scarring were noted, but all resolved conservatively. These findings are consistent with the known safety profile of Z-plasty, which, unlike skin grafting, avoids donor site morbidity and promotes better tissue match and pliability.6,8

Limitations of this study include the single-center design, lack of a control group using grafting techniques, and a relatively short follow-up duration (mean 5.6 months). Long-term follow-up would be necessary to evaluate recurrence rates, particularly in high-risk populations such as burn patients. Additionally, while the choice of technique was based on anatomical suitability, randomization was not applied; hence, bias in technique selection cannot be excluded.

Nevertheless, this study adds to the growing body of evidence that Z-plasty remains a cornerstone in reconstructive hand surgery. Its technical versatility and reproducibility make it applicable in both high-resource and limited-resource settings.

5. CONCLUSION

Z-plasty is an effective and low-risk technique for releasing digital contractures and restoring hand function. Five-flap and double-opposing Z-plasty provide greater functional improvement in web space contractures, while single Z-plasty remains effective for linear joint contractures. These techniques offer reliable outcomes without the need for skin grafting, supporting their continued use in reconstructive hand surgery.

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ILLUSTRATIVE CASE

A 33-year-old man developed a flexion contracture of the right ring finger following K-wire fixation for a proximal phalanx fracture. Two months post-injury, he presented with a −40° extension deficit at the PIP joint and a volar scar. Flexion remained at 85°, with functional limitations (DASH 46, VAS 3/10).

He underwent single 60° Z-plasty for scar release and wire removal. At 3 months, full extension and 90° flexion were achieved. DASH improved to 18, and satisfaction rose to 8/10. No complications were noted.

This case highlights the efficacy of single Z-plasty in restoring function and aesthetics in post-traumatic finger contracture.

Figure 2. Progressive improvement in ring finger extension and surgical scar maturation with dorsal view showing Z-plasty incision lines

Figure 3. At 3-day follow-up: full extension restored

Figure 4. Final outcome in extension and aesthetics.