Z-Plasty for Release of Postburn Finger Contractures in Pediatric Patients

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ABSTRACT

OBJECTIVES: **Finger contractures after burn injuries remain significant problems in pediatric patients. The severity of the contracture increases with age. In this study, we describe the technical details and importance of contracture treatment with Z-plasty in patients with finger contractures.**

MATERIALS AND METHODS: **For this study, we included 48 patients younger than 18 years of age who developed finger contractures after burn injuries. All patients had restricted finger movements because of contracture, and all patients received single or multiple surgeries with the Z-plasty technique. We did not include patients who could not be followed up for more than 1 year.**

RESULTS: **Complete recovery was observed in all 48 patients with daily dressing. We did not observe any infections, hematomas, suture separations, or total necrosis in any of the patients. We provided full-thickness skin grafts to 8 patients (16.7%). Seven patients (14.6%) developed superficial necrosis in the distal end of the flaps. None of the patients required additional surgical interventions.**

CONCLUSIONS: **The Z-plasty technique has an important place in the treatment of burn contractures. Simple and rapid recovery can be achieved with a single or with multiple z-plasty surgeries both in complicated cases, which have functional limitations, and in simple cases.**

KEY WORDS: *Burn injuries, Contracture release*

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INTRODUCTION

A burn contracture of the extremity is a challenging problem to the burn surgeon. Contractures mostly arise when adequate burn care and delivery have not occurred and when scar management has not been instigated in a vigorous manner. Contractures have important functional, cosmetic, and psychological consequences for the patient.[1]

Contracture release is an important part of burn management. Although compression garments, massage, and physical therapy exercises are recommended to prevent hypertrophic scars and skin damage that may occur in the early period, scar contractures and functional limitations that may occur after years can have major effects, especially in pediatric patients.

Serious contractures that may cause limitations of movement may develop in various parts of the body after deep burns. Treatment options vary according to the severity of the developing contracture and the area where it occurs. Skin grafts, local flaps, free flaps, and geometric release techniques are among the frequently used treatment methods.[2-4] The main goal of all these treatment methods is to achieve a good functional result by providing sufficient elongation in the contracture area. Breaking the contracture band with multiple Z-plasty techniques and excision of the scar tissue is a known treatment approach in the management of burn contractures that occur after years and that have caused functional limitations. Although there may be a need for multiple surgeries, patients with burn injuries can also receive treatment of burn contractures with the Z-plasty technique. In addition to being a simple protocol, patients return to their normal lives after a rapid recovery period. The Z-plasty technique is a potential alternative to other well-known methods, as reported by Gümüş.[5]

In this study, we describe the technical details and importance of finger contracture treatment after burn injuries with the Z-plasty technique.

MATERIALS AND METHODS

This study included 48 patients with late-stage burn contracture who were seen at the plastic reconstructive and esthetic surgery clinic of Kocaeli University from 2015 to 2021.

Patients were between 3 years and 18 years of age with a mean age of 6 years. Of total patients, 21 (44%) were female and 27 (56%) were male patients. Contractures were classified as mild according to the algorithm for the release of burn contractures defined by Hudson and Renshaw, as all joints had more than 50% of the normal range of motion.[2] We applied Z-plasty to 40 patients with more than 50% range of motion, as suggested by the Hudson and Renshaw algorithm. We applied full-thickness skin grafts (FTSGs) together with Z-plasty in 8 patients with less than 50% range of motion.

After the Penrose drain was removed, patients were discharged on the first postoperative day. The patients were followed up at outpatient clinics. Daily dressing changes were done. A splint was applied for 5 to 7 days. Patients received physical therapy treatment, including early active movements, in the third postoperative week. Compression garments, silicone gel, and massage were routinely applied to all patients at the third postoperative week to prevent hypertrophic scarring.

Surgical technique

A preoperative Z-plasty technique was made to release the contracture band. Multiple Z-plasties with 60-degree angles were planned throughout the skin. The number of flaps were decided according to the size of the scar. In brief, the main angle was incised along the length of the scar, and undermining was performed toward both sides over the paratenon. The short arms of the flaps were incised until the scar and with a right angle against the scar, and fasciocutaneous flaps were totally raised and transposed to their new locations, with incisions closed with 4/0 to 5/0 monofilament absorbable sutures. Bleeding was stopped with cautery when required. The critical point in this technique is that, when the flap is raised over the paratenon, the required flap thickness is obtained, and, in cases when FTSGs are necessary, a suitable vital ground is provided. The inguinal region was preferred for the graft donor site. A FTSG was adapted over the paratenon in patients who developed skin defects after contracture releasing. Penrose drains were placed for a day in the operation areas. With the hand held in the intrinsic plus position, short arm splints were applied for wound healing for 5 to 7 days. After a viability control was performed, the operation was terminated.

RESULTS

All 48 study patients were successfully treated. No major complications such as infection, hematoma, flap loss, and suture separation were observed. In 7 patients (14.6%), superficial necrosis developed in the distal end of the flaps (Table 1). None of these patients required additional surgical interventions. Complete recovery was observed in all patients with daily dressing. Mupirocin-included ointment was applied to the areas of superficial necrosis at each dressing. An increase in range of motion was observed compared with before the surgery.

The patients were seen in our outpatient clinic at week 1, week 3, month 2, month 6, and month 12. Range of motion increased after physical therapy compared with before the surgery. No graft loss was observed in the 8 patients who underwent FTSG in addition to Z-plasty. Clinical photographs are shown in Figure 1 and Figure 2.

DISCUSSION

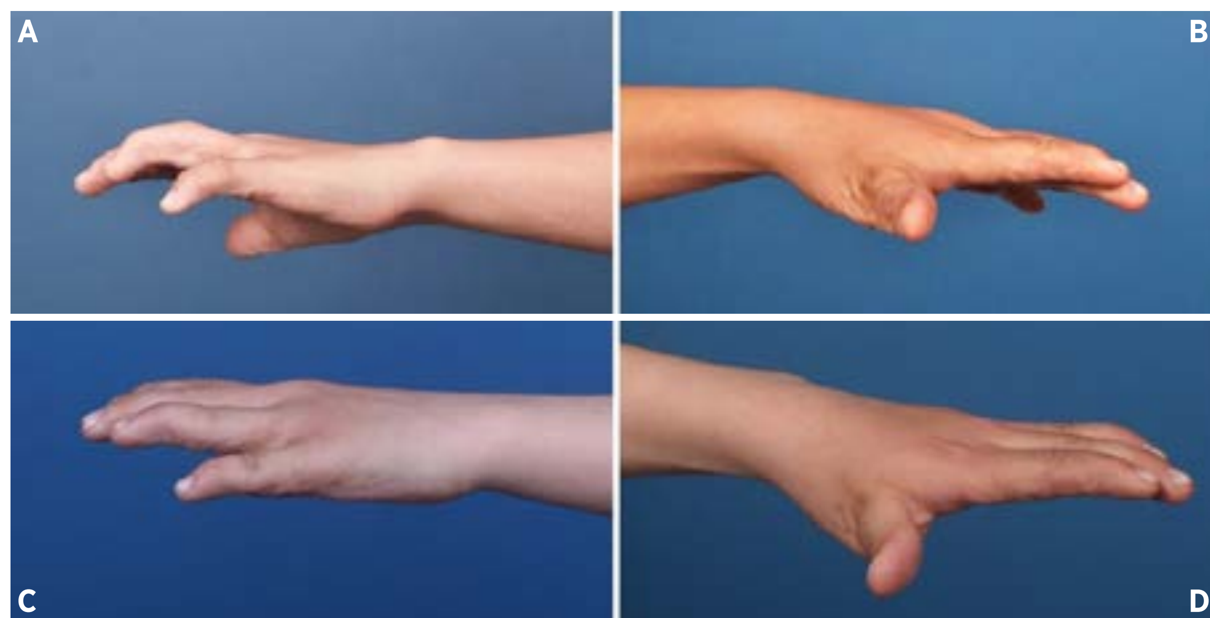
Z-plasty is one of the most useful techniques to release linear scar contractures. This technique can improve elongation along the axis of the scar, dispersal of the scar followed by breaking up the straight-line scar, and realignment of the scar within the lines of minimal tension.[6]

Contractures that occur after deep burns and cause limitations to movement continue to be a serious problem, especially in developing countries. Skin grafts, local flaps, and regional or distant flaps are used in the treatment of contractures. In the Z-plasty method, which is the most preferred method among local flaps, the use of triangular flaps can loosen and lengthen the contracture area. However, inadequate vascular supply to the wound, which is frequently seen especially at the distal end of triangular

TABLE 1. Patient Characteristics (N = 48)

Characteristic	Data
Age (range)	6 years (2 months to 9 years)
Sex, No. (%)	
Male	27 (56%)
Female	21 (44%)
Complication (superficial necrosis), No. (%)	7 (14.5%)
Follow-up period (range), months	15 (12-20)

FIGURE 1. Images of Treatment in 8-Year-Old Patient



(A) (B) Multiple finger contractures after burn injury in an 8-year-old patient. Multiple contracture bands are seen in the proximal phalanges of the second, third, fourth, and fifth fingers and in the first web space.

(C) (D) Postoperative view at 18 months.

flaps prepared from deep burn areas, can cause delayed healing. Therefore, various alternative geometric flaps can also be made.[3]

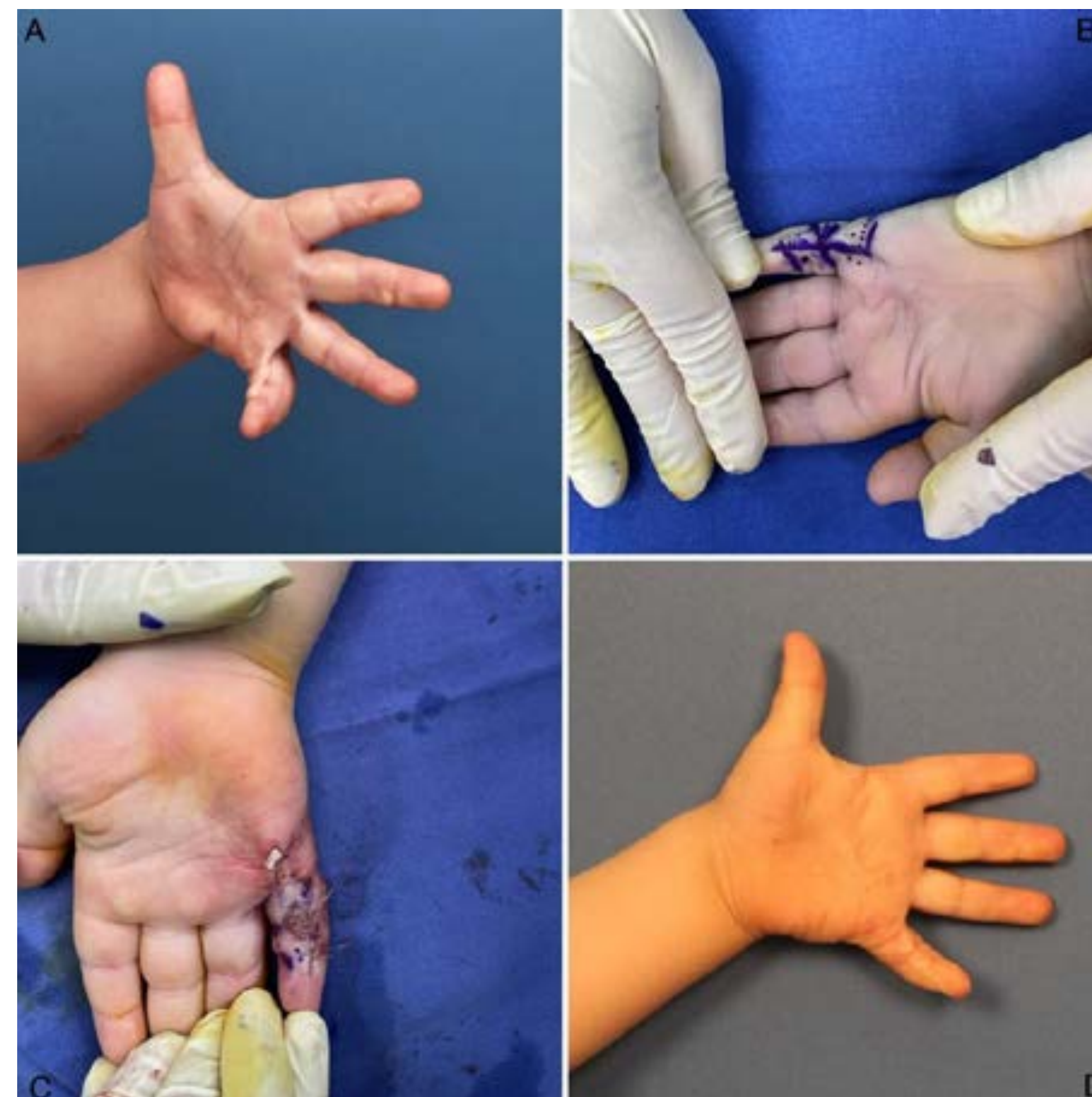
Optimum treatment can occur when teams plan for at least 2 consecutive Z-plasties in patients with extensive contractures and in whom the necessary correction is not possible with a single Z-plasty. This variation adds 2 extra limbs to the respective end of the central incision of a regular Z-plasty and results in a considerable gain of length.[7] As first described by Limberg in 1929, advantages of this technique result from its application to areas that are highly constricted in their natural mobility by scar contractures such as the neck, elbow, or interdigital spaces.[8,9] In the patients described here, we decided on the Z-plasty number according to the length of the contracture, with larger Z-plasties whenever possible. With smaller size Z-plasty flaps, there is a higher risk of flap necrosis. We obtained the largest possible Z-plasty flaps with the midlateral line border on the finger. The lateral legs of the Z-plasty flaps were designed not to include the articular borders. We applied the classical Z-plasty technique without using any modifications in our patients. We applied the double opposing Z-plasty technique in the interdigital web space.

Necrosis is a common complication, especially at the distal ends of the flaps. In our study patients, the distal ends were totally raised after undermining was performed toward both sides over the paratenon. Thus, we aimed to prevent thinning in the distal ends of the flaps. Incisions should be made perpendicular; that is, the maximum possible subcutaneous tissue should be left on the flap.

Single Z-plasty may not be enough for long contracture bands on the fingers due to the limited size of these areas. For these areas, multiple Z-plasties are needed. How many Z-plasties should be done is a controversial issue. Another multiple Z-plasty series was reported by Hashem in 2009. The 5-flap Z-plasty can be effectively used to release (grade I and II) flexion contractures of the digits, obviating the need for complicated flap procedures with their risks of failure, inadequacy, and donor site morbidity and allowing a single-stage procedure.[10]

In the contracture release technique with Z-plasty, the angle degree that provides the maximum elongation in the mid-leg with the least tension during closure is an angle of 60 degrees.[3] The theoretical elongation rate obtained with a 60-degree Z-plasty is 75%. Furnas and Fischer[11] showed that the elongation rate calculated mathematically is less in practice and the main rate can be between 55% and 84% of the predicted theoretical elongation. In other words, in practice, a true elongation of between 41% and 63% in mid-leg length can be achieved with a 60-degree Z-plasty.[12] We also planned Z-plasties at 60 degrees in our study patients. Thus, we ensured that the tension was low, and we have elongated up to 75%.

FIGURE 2. Images of Treatment in 2-Year-Old Patient



(A) Contracture in 5 fingers in a 2-year-old patient after burn injury. Contracture band is seen in the proximal and middle phalanges of the fifth finger. **(B)** Double Z-plasty was planned for the proximal and middle phalanges of the fifth finger. **(C)** Perioperative images are seen after flap adaptation. **(D)** Postoperative view at 12 months.

A limitation of this study was the inability to measure postoperative range of motion in patients. Because most of the patient population were younger pediatric patients, there was difficulty in cooperation.

CONCLUSIONS

Z-plasty provides a useful option for the release of any kind of contracture; this technique is safe, simple, and effective. However, it should be kept in mind that, in severe contractures, skin grafting may be required after Z-plasty.

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