

New Advantages of Double Combined Z-Plasty for Wide Burn Scar Contracture

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ABSTRACT

OBJECTIVES: The double combined Z-plasty technique was developed for treating wide scar contractures. The major advantages are that the scar can be completely divided by the skin inserted from both sides, a greater elongation effect can be obtained in the full width of the scar than with conventional Z-plasty, the zigzag suture line prevents recurrence of contractures, the design is simple, and the procedure is easy. We successfully treated a variety of burn scar contractures using this technique and had additional advantages that were not documented in the original report.

MATERIALS AND METHODS: We treated 3 cases of burn scar contractures using the double combined Z-plasty technique.

RESULTS: The burn scar contractures were successfully released by this technique. The technique allows for expansion and growth in small children with adequately sized triangular flaps of intact skin. In addition, the flap size can be adjusted according to needs during the procedure. Even when the surrounding skin is a scar tissue, the technique can provide a marked improvement. In addition, this technique is well-suited to multidirectional joints such as the neck and axillar area.

CONCLUSIONS: Burn scar contractures require varying techniques according to the degree, width, and area affected. The double combined Z-plasty should be considered as an effective technique for wide burn scar contractures.

KEY WORDS: *Axilla contracture, Contracture release, Neck contracture*

INTRODUCTION

Among various types of burn scar contractures, linear scar contracture is the most effectively treated by conventional Z-plasty.^{1,2} However, wide scar contractures are sometimes difficult to treat with Z-plasty or its variations. In 2013, Yotsuyanagi and colleagues developed a new surgical technique, the double combined Z-plasty,³ which has since been widely used. In this technique, a triangular flap from each side of the scar is inserted, allowing the edges of the scar to be separated in opposite directions. The technique can be easily adjusted for wide scar contracture or other diseases, such as pterygium colli. We report the successful treatment of various burn scar contractures with this technique and highlight new advantages that have surfaced since the introduction of the technique.

MATERIALS AND METHODS

Case 1

A 9-year-old girl had flame burns from an explosion, which affected 71.5% total body surface area (TBSA), including her face, neck, abdomen, back, and both upper limbs. Almost all of the burned areas were deep dermal or deep burns. The patient had undergone 9 surgeries, including skin grafting with cultured epidermis. However, various areas were affected by scar contractures. The patient could not raise her left upper arm because the posterior axillary line was contracted by the neighboring hard scar in both the shoulder and the back (Figure 1A). The posterior axillary area was not injured with burns.

Double combined Z-plasty was used to treat the contracture (Figure 1B). The length of each limb was 4 cm. The skin incision line (S limb) was designed to straddle the entire contracted area at a right angle to the contracture direction on the posterior axillary line. Two Z-plasties

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were designed on either side of the S limb, with both central limbs (C limbs) at right angles to the S limb and in opposite directions at both sides. The last limbs (L limbs) were made at 60-degree angles from the C limbs.

The S limb and C limbs were incised first. The contracture was released well, but the skin defect was greatly enlarged. It was determined that the 60-degree angle between the C and L limbs would yield inadequate skin flaps, so all of the Z-plasty angles were increased to 90 degrees. The 2 flaps could then be transposed with little undermining, smoothly covered the skin defect, and were easily sutured without tension (Figure 1, C and D). The left axillary skin involving the underarm hair area remained intact, and no deviation of this area occurred after the operation. Postoperatively, the wound healed well with no complications, such as congestion or necrosis. During the 5-year follow-up, no recurrence of the contracture has been observed, and the 2 triangular flaps of intact skin inserted between the scar expanded well with her growth. The patient has maintained full range of motion in her left arm (Figure 1E).

In addition, the medial scar contracture of the patient's right knee was also treated with this technique (Figure 1F). Although the entire area of operation was covered by thick scar or grafted skin, the technique was easily performed (Figure 1, G and H). The length of each limb was 3 cm. The postoperative course was uneventful, and the wound healed well. The contracture was improved with no recurrence (Figure 1I).

Case 2

A 37-year-old woman had flame burn over 26% TBSA, including her neck, chest, abdomen, and both upper limbs. Almost all of the burned areas were deep dermal or deep burns. She underwent 4 debridement procedures and split-thickness skin graft, and all of the wounds were healed. However, severe contracture appeared extensively in the neck, anterior chest, and both axillary regions. The scar contracture in the neck and anterior chest was treated by free anterolateral thigh flap transfer and bilateral reduction mammoplasty 10 months after the injury. However, the scar contractures along the bilateral anterior axillary lines remained (Figure 2A).

We performed double combined Z-plasty 1 year after the injury (Figure 2, B and C). The length of each limb was 4.5 cm. Although the entire area was covered by grafted skin, this technique was easily performed (Figure 2, D and E). Some of the left axillar skin involving the underarm hair area remained intact, and no deviation of this area occurred.

The postoperative course was uneventful, and the wound healed well. During more than 3 years of follow up, the

contracture was remarkably improved with no recurrence (Figure 2F).

Case 3

A 47-year-old man had burn injury to 30% TBSA, including his face, scalp, neck, both upper limbs, anterior chest, and back, caused by flames from ignited kerosene. Almost all of the burned areas were deep dermal or deep burns. The patient underwent 3 operations for debridement and skin grafting for wound closure. In addition, 7 operations were necessary to release and reconstruct scar contractures in the neck and digits. At the final operation, the scar contracture in the left anterior axillary line was treated with double combined Z-plasty.

The scar bundle was wide and had web formation at the cranial end but narrow at the caudal end (Figure 3A). Both of the triangular flaps were placed on the intact skin. The length of each limb was 2.5 cm. After the operation, the scar contracture was completely released (Figure 3B). The edges of the scar were widely separated. The wound healed well with no complications, such as congestion or necrosis. During more than 6 years of follow-up, there was no recurrence of the contracture (Figure 3C).

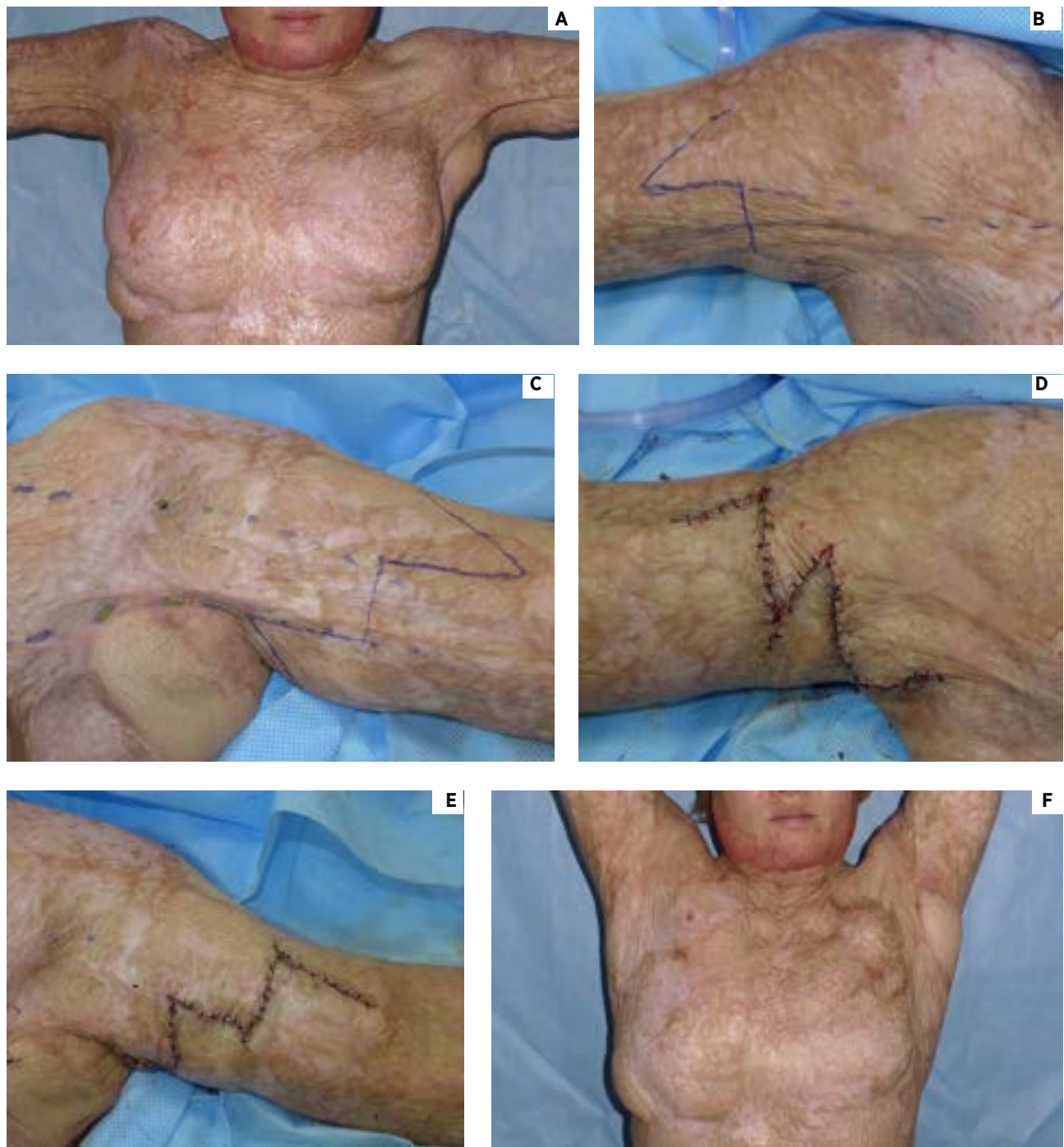
DISCUSSION

Linear scar contracture is often well treated by conventional Z-plasty or variations,^{1,2} such as unequal Z-plasty or four-flap,⁴ five-flap,⁵ or seven-flap Z-plasty.⁶ However, wide scar contracture is sometimes difficult to treat with these techniques because the scar is incompletely released, and the consecutive scar will consequently be reformed, resulting in recurrent contracture.

Various techniques derived from Z-plasty have been developed to treat wide scar contracture.⁷ Running V-Y plasty is an effective technique and is easily designed.⁸ However, each V-Y plasty has only minimal effect in releasing the contracture, and the effect is even less when the flap is made within the scar. Therefore, many V-Y plasties may be necessary, and procedures become complicated. The multiple Z-plasty has similar advantages and disadvantages.² In addition, partial congestion or necrosis easily occurs when the flap is made inside the scar, as undermining is required beneath the flap. The trapeze-plasty flap and square flap are similar procedures,^{9,10} but they require intact skin in the neighboring area, and the flap must be greatly advanced. All of these techniques can produce the zigzag effect, which prevents the recurrence of contracture when intact skin is used, but the effect is decreased when these techniques are adapted for larger scar areas. The double opposing rectangular advancement technique can achieve a large release of the scar contracture.¹¹ However, this technique is only applicable for a

FIGURE 1. Case 1: 9-Year-Old Girl With 71.5% of Total Body Surface Area Burn Injury

A, Severe burn scar contracture on the posterior axillary line. The patient could not raise her left arm. **B**, Flap design. S limb was designed directly across the major contracted scar. Both C limbs were designed at right angles to the S limb and in opposite directions at both ends. L limbs were made at 60-degree angles from the C limbs. **C**, Each flap could be transposed without tension. **D**, After application of double combined Z-plasty. **E**, After contracture release. Two triangular flaps inserted between the scar expanded well with her growth, and the patient has maintained full range of motion in her arm. **F**, Burn scar contracture in the medial part of right knee. Contracture could be treated with the same technique, even though the entire area of operation was covered by a thick scar. **G**, Flaps were elevated and transposed. **H**, Appearance after operation completion. **I**, Contracture was improved with no recurrence.

FIGURE 2. Case 2: 37-Year-Old Woman With 26% of Total Body Surface Area Burn Injury

A, Severe burn scar contracture on the bilateral anterior axillary lines. Patient could not raise both arms. **B,** Design of flaps on right axilla. **C,** Design of flaps on left axilla. **D and E,** Appearance after operation completion. **F,** After contracture release. Patient has maintained full range of motion in both arms.

limited scar area, and the reformed scar is parallel to the contracture direction that causes recurrence.

Another variation of the technique involves the use of subcutaneous pedicled scar flaps,¹² as in the circumferential incision technique,¹³ double opposing V-Y-Z plasty,¹⁴

and subcutaneous pedicle rhomboid flap.¹⁵ The concept behind these techniques is that the contracted scar area is incised circumferentially, and the surrounding skin is undermined and enlarged. Because the central scar area is not undermined, the blood supply is maintained and the contracture is released effectively. However, the effective

FIGURE 3. Case 3: 47-Year-Old Man With 30% of Total Body Surface Area Burn Injury



A, Severe contracture in the left anterior axillary line. **B,** After application of double combined Z-plasty. **C,** After contracture release. There was no recurrence of the contracture.

release of the contracture depends on the condition of the surrounding skin, and extending the scar peripherally may not be adequate. The propeller flap is a similar technique in that the contracted scar is incised circumferentially.¹²

The scar flap requires undermining in the peripheral area and rotation, and it is nourished by the perforating vessels. However, this technique can be used only for areas with adequate perforator vessels, such as the groin, popliteal fossa, and fingers. This technique sometimes requires simultaneous skin grafting.

The double combined Z-plasty is one of the techniques derived from Z-plasty.³ The following are the major advantages of this technique: (1) the scar can be completely divided by normal skin inserted from both sides; (2) a larger elongation effect can be obtained over the full span of the scar than with conventional Z-plasty; (3) the zigzag suture line prevents recurrence of contracture; (4) the design is simple; and (5) the procedure is easy. It is important to note that the triangular flaps should be placed on intact skin; therefore, the technique may not be applicable when the surrounding skin is scar tissue.

Our cases demonstrated the advantages of the double combined Z-plasty technique. In case 1, the contracture on the posterior axillary line was released by the intact triangular skin flaps. Although the surgery was completed when the patient was a child, the contracture did not recur during her growth. This shows that the insertion of sufficient intact skin can have a tissue expander effect. In addition, flap size can be altered as necessary during the procedure. In this case, the contracture was released by the incision of the S and C limbs, before the incision of the L limb. This allowed an intraoperative assessment of the necessary triangular flap size and a change in the planned angle between the C and L limbs from 60 to 90 degrees. Although treatments for the knee in case 1 and the anterior axillary line in case 2 were performed in the surrounding scar area, great improvement was noticed in both cases. The results clearly demonstrated that this technique may be useful even in cases where the surrounding skin is scar tissue.

Case 3 illustrated the major elongation that can be achieved with this technique. The narrow scar bundle was well treated despite the short incision limbs. Furthermore, this technique has been performed with good results for many cases, involving multidirectional joints, such as the neck and axillary area. This technique can also be performed without affecting the peripheral areas, such as the axillary or popliteal fossae.

CONCLUSIONS

Our cases showed that the double combined Z-plasty has additional advantages in treating wide scar contracture with the help of real-world examples, demonstrated in the original report for the technique. A variety of surgical techniques must be used to treat burn scar contractures, depending on the degree, width, and area affected. The

double combined Z-plasty should be considered as one of the effective techniques for wide burn scar contracture.

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