

# Repairing post burn scar contractures with a rare form of Z-plasty

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## ABSTRACT

**BACKGROUND:** Although many precautions have been introduced into early burn management, post burn contractures are still significant problems in burn patients. In this study, a form of Z-plasty in combination with relaxing incision was used for the correction of contractures.

**METHODS:** Preoperatively, a Z-advancement rotation flap combined with a relaxing incision was drawn on the contracture line. Relaxing incision created a skin defect like a rhomboid. Afterwards, both limbs of the Z flap were incised. After preparation of the flaps, advancement and rotation were made in order to cover the rhomboid defect. Besides subcutaneous tissue, skin edges were closely approximated with sutures.

**RESULTS:** This study included sixteen patients treated successfully with this flap. It was used without encountering any major complications such as infection, hematoma, flap loss, suture dehiscence or flap necrosis. All rotated and advanced flaps healed uneventfully. In all but one patient, effective contracture release was achieved by means of using one or two Z-plasty. In one patient suffering severe left upper extremity contracture, a little residual contracture remained due to inadequate release.

**CONCLUSION:** When dealing with this type of Z-plasty for mild contractures, it offers a new option for the correction of post burn contractures, which is safe, simple and effective.

**Key words:** Advancement; contracture; relaxing incision; rotation; Z-plasty.

## INTRODUCTION

Although many precautions such as splints, pressure therapy, massage and rehabilitation have been introduced into the early burn management to avoid forming scar contracture and soften the hypertrophic scar after skin damage, post burn contractures are still significant problems in burn patients. They usually take place over flexor surfaces of the joints, and either restrict limb, hand, foot, finger or neck motions or deform the skin cover of the affected area, and commonly, surgical correction is necessary to release them completely.

Minimal contractures may be released by a simple Z-plasty;

however, moderate ones may require various forms of multiple Z-plasties, and more complicated ones like severe contractures may be released effectively with skin grafts and flaps such as local flaps, regional flaps, transposition flaps, rotating flaps, axial flaps, perforator flaps, and free flaps. Many of the methods described to treat them can be used under proper indications to obtain the best results both cosmetically and functionally since they still have some disadvantages such as necrosis, donor site morbidity, long operation time, and difficult surgical dissection.<sup>[1-4]</sup> Although new clinical researches focus on finding more simple, reliable and versatile alternatives, simple Z-plasty and various forms of multiple Z-plasties are being used most commonly in daily clinical practice. In this study, clinical experience in a rare form of Z-plasty combined with relaxing incision for the release of scar contractures was presented.

## MATERIALS AND METHODS

This study included sixteen patients who had post burn scar contractures treated successfully with an unusual form of Z-plasty called Z advancement rotation flap (ZAR). Patients were between 3 and 25 years of age with a mean age of 10.3 years. The patients suffered from a contracture for a mini-

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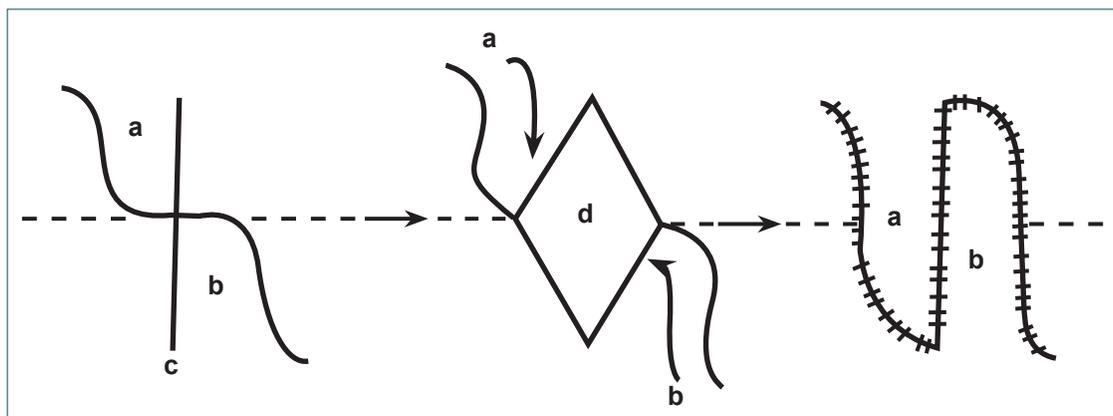
**Table I.** Clinical details of patients

Case no.	Age	Sex	Average time from burn to operation (months)	Location	Complication	Follow-up (months)	Result
1	7	Male	14	Axilla	No	14	Good
2	9	Male	23	Poplitea	No	4	Good
3	13	Male	19	Elbow	Scar enlargement	21	Acceptable
4	11	Male	13	Axilla	No	13	Good
5	25	Female	15	Elbow	No	9	Good
6	7	Male	26	Forearm	No	16	Good
7	14	Male	38	Upper extremity	Inadequate release	16	Reoperation
8	8	Male	22	Elbow	No	17	Good
9	3	Male	12	thigh	No	6	Good
10	10	Female	27	Axilla	No	15	Good
11	17	Male	13	Upper extremity	No	17	Good
12	9	Female	16	Upper extremity	No	13	Good
13	11	Female	14	Elbow	No	11	Good
14	7	Male	12	Neck	No	13	Good
15	8	Male	13	Upper extremity	No	14	Good
16	7	Male	16	Elbow	No	13	Good

imum of one year so scar maturation was completed enough to release it. Contractures were in mild severity except in one in which there was a severe contracture of upper extremity. As all joints had more than 50% of normal joint range of motion (ROM), contractures were classified as in mild severity according to the algorithm for the release of burn contractures described by Hudson.<sup>[1]</sup> The treated sites were the axilla in three patients, the poplitea in one patient, the elbow in five patients, the upper extremity in four patients, the forearm in one patient, the neck in one patient, and the thigh in one patient (Table I).

Preoperatively, a Z advancement rotation flap combined with

a relaxing incision was drawn on the contracture line (Fig. 1). While limbs of the Z were being placed lateral to the contracture, relaxing incision line was drawn just over the contracture area perpendicular to the contracture line (Fig. 2a-d). Length and width of the limbs of the ZAR flap, which had a modified shape of classical Z-plasty suitable for advancement and rotation, were determined according to the need of flap size which would cover the skin defect arising from the released contracture line. After marking was completed, firstly, relaxing incision was made into the skin and scar tissue, and deepened to the superficial fascia, releasing the contracture completely without leaving any contracture band (Fig. 2b). The depth of incision varied according to the characteristics



**Figure 1.** Schematic illustration of the procedure. a and b represent flaps of the Z-plasty, and c and d show relaxing incision line and skin defect in rhombus shape, respectively. When relaxing incision is made, a rhomboid defect, 'd' develops. After flap incisions, a and b flaps are advanced and rotated into the rhombus, and then, they are sutured to each other.

of the scar being treated. In some cases, the incision involved only skin and superficial layer of fat, whereas, in others, a deep incision through the fascia was necessary. This incision created a skin defect in shape of a rhomboid on the contracture line (Fig. 2b). Then, both limbs of the Z flap were incised on the lateral sides of the rhomboid defect (Fig. 2c). Tips and margins of the limbs were freed a few millimeters from the fascia with sharp dissection, which would facilitate advancement and rotation of the flaps into the defect over subcutaneous pedicle without developing any deformation of the skin surface like wrinkles. After preparation of the flaps, advancement and rotation were made easily in order to cover the rhomboid defect. With subcutaneous stitches, angles of the wound were closely approximated to the tips of the rotated and advanced flaps, and then, besides subcutaneous tissue, skin edges were sutured in the usual manner (Fig. 2d).

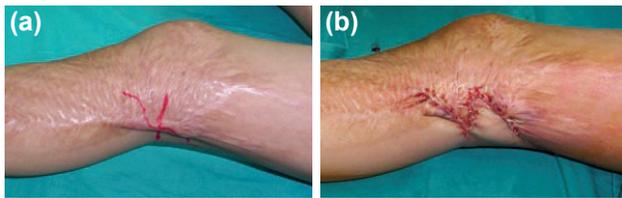
## RESULTS

This Z-plasty procedure was used in the treatment of seventeen scar contractures of sixteen patients, whose ages ranged from 3 to 25 years, with twelve male and four female

patients. Mean age was 10.3 years. None of the patients had undergone any operation for the release of contracture before. All rotated and advanced flaps healed uneventfully without encountering any major complications such as infection, hematoma, flap loss, suture dehiscence or flap necrosis (Figs. 2-4). All contractures were released completely without the need of any skin grafts or additional Z-plasties and local flaps. In the operation, movement of the limbs of the Z flap was quite simple and easy, providing maximum release of the contracture line. During the suturation of the wound edges together, some skin wrinkles developed at the suture line due to the approximation of the incision lines, and continued in the early postoperative period, and then resolved spontaneously. In all but one patient, contractures released effectively by means of using one or two Z-plasty, and normal joint range of motion was achieved completely. In one patient suffering severe left upper extremity contracture, little residual contracture remained after the intervention due to the inadequate release in the operation. In the follow-up period of 13 months, it didn't resolve and necessitated releasing with a re-operation, suggesting that contracture release by using only one Z-plasty as done in this case was insufficient to release



**Figure 2.** (a) Preoperative view of Patient 8 who had significant elbow contracture. A ZAR flap and relaxing incision line were marked on the elbow. (b) Relaxing incision emerged a skin defect like a rhomboid shape. (c) Flaps were sutured. (d) Seventeen months postoperatively. (e) Patient 4 who had anterior axillary contracture. (f) The ZAR flap and relaxing incision line were marked. (g) Appearance of the contracture line just after the procedure was completed. (h) Thirteen months postoperatively. (i) A mild forearm contracture of the patient 6. (j) Preoperative marking of the ZAR flap and relaxing incision. (k) View of the flaps after the suturation. (l) Sixteen months postoperatively. (m) Severe upper extremity contracture of Patient 7. (n) Preoperative marking of the ZAR flap and relaxing incision. (o) Just after the release of the contracture with a large ZAR flap. (p) Late postoperative results showing inadequate release. Note that it needs releasing again.



**Figure 3.** (a) Preoperative appearance of a popliteal contracture. (b) Early postoperative results indicate complete releasing of it.

severe contractures completely and they were in need of placing at least two Z-plasties for adequate correction (Fig. 2m-p). Follow-up time ranged from 4 to 21 months with a mean of 13.2 months. No recurrence of the contracture was observed in this period.

## DISCUSSION

Burn contracture seems to be preventable in the early post burn period with regular therapy sessions by means of rehabilitation, splinting, pressure therapy and massage; however, many patients suffer from the disability arising from the contractures, particularly after insufficient primary care or deep burns. Contractures, especially when involving the joints, lead to challenging problems which may cause severe functional impairments related to the activities of daily life.

The first step to treat a contracture is making an adequate contracture release, for which releasing incision is the most preferred and effective way. The second component of treatment consists closing the wounds, for which a number of different methods are available including skin grafting, Z-plasty, local/regional flap, island flap, perforator flap, and free flap. In clinical practice, combined methods which offer both the release and resurfacing of the contracture in the same session are usually preferred in many cases because they are simple, easy and fast. Various types of Z-plasties provide both the release and closure of the contractures successfully, especially in mild contractures.<sup>[1]</sup> Up to now, many forms of Z-plasties

have been described and used successfully in the treatment of scar contractures, whose shapes, number of limbs, degree of angles, size of triangular flaps and transposition procedures differ from each other in designing and using them. In addition to simple Z-plasty, there are multiple serial, four-flap, five-flap, six-flap, seven flap, v-y, running v-y, double-opposing and single limb Z-plasties, and other variations.<sup>[3,5-9]</sup>

X-plasty is a form of Z-plasty described for partial coverage of joints after the release of contractures of the fingers. This method consists of two opposing triangular flaps which partially advance the opposing 'Vs'. The rest of the defect areas arising from contracture release are covered by skin grafts.<sup>[10]</sup> In the ZAR technique, flaps which are nearly in quadrangular shape, are significantly larger than triangular flaps and when totally advanced to the corner of the rhomboid defect, all surface of the contracture is covered completely without necessitating skin grafting. Burow's triangles at the base of the flaps are advanced into the defect area by incising the flap base in oblique fashion to use the excess tissue next to the contracture band efficiently.

V-N plasty is a variation of X plasty used effectively for the release of the contractures of the web spaces. All available tissues in the web space can be utilized as a local flap in this approach.<sup>[11]</sup> It has a similar design to X plasty, involving an X incision and two triangular flaps. The two opposing Vs of the X is obliquely advanced to lie side by side, giving an N shape to the contracture band. However, the technique is in need of adding multiple Z-plasty procedures to the rest of the contracture band like a five-flap plasty; otherwise, it is not enough to release a contracture band and cover a contracture defect. It doesn't use the Burow's triangles effectively. In our presented method, there was no need for additional Z-plasty procedures and skin grafting because of the larger flap design and the use of Burow's triangles which make the local tissues near the contracture band more convenient and useful for the coverage of contracture defect.



**Figure 4.** (a) Minimal contractures of arm and forearm. (b) Preoperative marking of flaps. (c) Appearance of the flaps after contracture release and flap dissection were completed. (d) Intraoperative view of the contracture areas after flaps were sutured. (e) Linear contracture band located at the cubital area. (f) Preoperative marking of a large flap. (g) Contracture was released entirely by using relaxing incision and flap incisions. (h) Appearance of the flaps in the early postoperative period.

Double reverse V-Y-plasty, namely diamond shape incision, is a different way to release a contracture.<sup>[6]</sup> Apart from ZAR flap, a relaxing incision is not utilized in this approach, but a diamond shape incision is localized along the maximum tension site of the contracture band. Moreover, lateral relaxation incisions are used transversely to provide additional release. Closure of the wound is performed in the way of suturing the wound edges in the V-Y and Y-V manner so V-shaped incision is transformed into a Y-shaped wound closure, and Y-shaped incision into V-shaped wound closure.<sup>[6]</sup> With this closure, a long linear scar is left over the contracture line, possibly resulting in a linear scar contracture. In this procedure, scar bands or tissues are not transposed from their directions to another way, and therefore, there is a strong possibility for recurrences to occur due to wound contraction in the healing period. In our approach, no linear scar was left over the contracture band, and contracture line was broken by the flaps, reducing the recurrence risk.

Rhomboid incision is another way to release scar contractures effectively. In this approach, contractures are released by using rhomboid skin incision, and then, lateral relaxation incisions are made to reduce the tension of the contracture sufficiently. Wound is closed in V-Y and Y-V fashion, without making any undermining, elevation, rotation or advancement of the rhomboid skin island.<sup>[5]</sup> This method is similar to double reverse V-Y-plasty technique and has the same disadvantages over the ZAR flap approach. Furthermore, it has been described primarily for hand contractures, and there is no information on its effectivity in the correction of other contractures.

An effective incision shape, namely circumferential incision, has been reported for the release of wide scar contractures. A spindle-shaped incision line is designed around the scar, whose major axis places along the direction of the contracture line. When sufficient release of the contracture is not achieved by a simple incision, the surrounding skin is slightly undermined, and then, skin defect is closed either by simply suturing, or by suturing the wound margins to each other in combination with Z-plasties.<sup>[8]</sup> Different from the ZAR flap, in the way of this closure, a linear scar is left on the contracture band, being capable of leading to a linear scar contracture. Also, scar bands or tissues are not transposed from their positions to another way so there is a strong possibility for recurrences to develop owing to the wound contraction in the healing period. Moreover, circumferential incision approach needs considerably more incisions and surgical dissection than the ZAR flap.

The seven-flap plasty and multiple Y-V plasty are other excellent techniques in the release of burn contractures. Their designs are suitable for the release of burn contractures located on the neck, axilla, cubital fossa, hand, perineum, and poplitea.<sup>[7,9,12,13]</sup> Successful outcomes and some modifications

have been reported after clinical experiences; however, these techniques need many incisions and significantly more surgical dissections when compared to the ZAR flap.

The ZAR flap was firstly described by J.W. Pate in the fifth international symposium of plastic and reconstructive surgery of the head and neck in order to cover rhomboid facial skin defects ranging 1 to 3.2 cm in diameters.<sup>[14]</sup> Thereafter, it was successfully utilized for hand contractures by making some modifications in the original description of the flap.<sup>[15]</sup> In this study, these modifications were used for the release of scar contractures which were mentioned previously. As ZAR flap was mainly described for the coverage of rhomboid shape defects, contracture wound arising from relaxing incision was accepted as a rhombus shape placed on the contracture line having corners and angles of a rhombus, and then, flaps were planned next to the defect area in a specific shape similar to a quadrangular shape. Flaps were not designed as a triangle and incisions ended at the base in an oblique way to facilitate the movement of Burrow's triangles into the contracture defect. One Z-plasty is enough to release only mild contractures while two or more Z-plasties are necessary for severe ones. As flaps are in need of only advancement and rotation over subcutaneous tissue without requiring any undermining or elevation, viability of flaps is protected against tip necrosis that usually appear in well-known classical Z-plasty flaps. There is no need for extensive dissection, a large number of skin incisions, skin undermining, lateral relaxing incisions, skin grafting and additional Z-plasty procedures to cover the contracture defect. It transposes and elongates contracture bands sufficiently without leaving a linear scar over the contracture line, reducing the recurrence risk. This procedure has also the advantages of simplicity and effectivity of a relaxing incision, and flap closure together without necessitating any additional procedures.

This type of Z-plasty provides a useful option for the release of mild contractures, which is safe, simple and effective. It seems to be a potential alternative to the other well-known methods.

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## ORJİNAL ÇALIŞMA - ÖZET

### Yanık sonrası skar kontraktürlerinin nadir bir Z-plasti yöntemi ile düzeltilmesi

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**AMAÇ:** Erken yanık tedavisinde birçok önlemler alınmasına rağmen, yanık sonrası kontraktürler yanık hastalarında hala ciddi bir problem olmaya devam etmektedir. Bu çalışmada, gevşetme kesisi ile birleştirilmiş bir Z-plasti şekli skar kontraktürlerinin düzeltilmesinde kullanıldı.

**GEREÇ VE YÖNTEM:** Ameliyattan önce kontraktür çizgisi üzerine gevşetme kesisi ile birleştirilmiş bir Z ilerletme çevirme flebi çizildi. Gevşetme kesisi kontraktür çizgisi üzerinde romboid şekilli bir deri kaybı oluşturdu. Ardından, Z-plastinin her iki bacağı kesildi. Fleplerin hazırlanması sonrasında, romboid deri kaybını kapatmak için fleplerin ilerletme ve çevirmesi yapıldı. Cilt altı dokunun yanısına, deri kenarları dikişlerle yaklaştırıldı.

**BULGULAR:** Bu çalışma Z ilerletme çevirme flebi ile başarılı olarak tedavi edilmiş yanık sonrası skar kontraktürüne sahip 16 hastayı kapsadı. Yöntem, flep nekrozu, dikiş açılması, flep kaybı, enfeksiyon ve hematoma gibi herhangi bir büyük komplikasyonla karşılaşmadan kullanıldı. Tüm ilerletilip çevrilen flepler sorunsuz iyileşti. Biri dışında tüm hastalarda, etkili kontraktür gevşemesi bir veya iki Z-plasti kullanarak elde edildi. Ciddi üst ekstremitte kontraktürü olan bir hastada, yetersiz gevşemeye bağlı az bir miktar artık kontraktür kaldı.

**TARTIŞMA:** Hafif kontraktürler için bu Z-plasti işlemi değerlendirildiğinde, yöntem güvenli, basit ve etkili olup, yanık sonrası kontraktürlerin düzeltilmesinde yeni bir seçenek sunmaktadır.

**Anahtar sözcükler:** Çevirme; gevşeme kesisi; ilerletme; kontraktür; Z-plasti.

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