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Klinik Çalışma

Difficulties with running V-Y plasty in releasing burn scar contracture

Yanık kontraktürü gevşetilmesinde ardışık V-Y plasti yöntemindeki sıkıntılar

Nazım GÜMÜŞ

BACKGROUND
Many approaches to the release of burn contracture have been described. Each offers some advantages for the treatment of contractures, but they have some limitations affecting their indications and outcomes. In this study, we attempt to describe clearly the difficulties with running V-Y plasty after our experience with this technique.

METHODS
This study included 21 patients with scar contracture. Preoperatively, for marking the flaps, a zigzag line, the angles of which were kept in the range of 60-90°, was drawn over the contracture line. The incision was firstly made into the skin to avoid retraction of the flaps, and then deep through the fascia, making advancement of the V flap easy by sliding. The V flap was advanced along the long limb of the Y on the base of a subcutaneous pedicle. After meticulous hemostasis, all incisions were sutured.

RESULTS
In most of the patients, successful release of the contracture was achieved without any complication. However, in a few cases, some challenging problems developed, suggesting possible limitations of the running V-Y plasty procedure.

CONCLUSION
When considering running V-Y plasty for the release of contracture, awareness of the related difficulties will be helpful and will facilitate selection of the cases suitable for the procedure to achieve successful results and avoid possible complications.

Key Words: Burn; complication; contracture; limitation; V-Y plasty.

AMAÇ
Yanık kontraktürü gevşetilmesinde birçok tedavi yaklaşımı tanımlanmıştır. Bunların her biri kontraktür tedavisinde bazı avantajlar sunarlar, fakat endikasyonlarını ve sonuçlarını etkileyen birtakım sınırlamalara sahiplerdir. Bu çalışmada, ardışık V-Y plasti yöntemindeki sıkıntılar, teknik ile elde edilen tecrübe sonrasında tanımlanmaya çalışıldı.

GEREÇ VE YÖNTEM
Bu çalışma 21 skar kontraktürlü hastayı kapsadı. Ameliyat öncesinde fleplerin belirlenmesi için, açıları 60-90° arasında tutulan bir zigzag çizgi kontraktür hattının üzerine çizildi. Kesi ilk olarak, fleplerin büzüşmesini engellemek için cilde yapıldı, sonra fasyaya doğru derinleştirildi. Böylece V flebinin kayma şeklinde ilerletilmesi kolaylaştırıldı. V flebi Y kesisinin uzun bacağı boyunca cilt altı pedikül üzerinde ilerletildi. Dikkatli kanama kontrolü sonrasında tüm kesiler dikildi.

BULGULAR
Hastaların çoğunda herhangi bir komplikasyon olmaksızın başarılı kontraktür gevşemesi sağlandı. Bununla birlikte, birkaç hastada bazı sıkıntılar gelişti ki; V-Y plasti yönteminin muhtemel sınırlanmalarını gösterdi.

SONUÇ
Kontraktür gevşetilmesinde V-Y plasti planlandığında, yöntemin zorluklarının bilinmesi, başarılı sonuçların alınması ve muhtemel komplikasyonlardan kaçınılması için, uygun olguların seçiminde yardımcı olup, kolaylaştıracaktır.

Anahtar Sözcükler: Yanık; komplikasyon; kontraktür; sınırlılık; V-Y plasti.

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Burn scar contracture is still one of the most complicated challenges in burn patients; it can develop either during or after wound healing, and sometimes results in disability of the extremities, neck and hands, or deformations in body parts affecting their form and functions. Although variable splints, massage, rehabilitation, and constant pressure therapy over the burned area have been used widely in the prevention of burn scar contracture, both burned and grafted skin areas tend to contract with time, leading to contracture of varying severity.

Many approaches to the release of contractures have been described, including Z-plasty, local flaps, regional flaps, transposition flaps, rotating flaps, axial flaps, perforator flaps, and free flaps.[1-3] While each of them offers some advantages for the treatment of contracture, which can present with grades of severity ranging from very simple to more complicated, they also pose some limitations in surgery affecting their indications and outcomes, and are not sufficiently successful in releasing each type of contracture. Simple Z-plasty can easily release a slight contracture; however, for more complicated contractures and in some cases where the available tissue is limited, other modalities such as multiple Z-plasties, skin graft, regional flaps, transposition flaps, rotating flaps, axial flaps, perforator flaps, and free flaps are necessary to achieve complete release.

As is well known, running V-Y plasty, namely multiple V-Y plasty, is one of the most effective techniques in Z-plasties, providing a simple, safe and easy surgical solution to burn contractures. Its main advantage over other Z-plasty techniques is the flap viability, which makes advancement of the triangular flaps safe without disturbing tip perfusion.

In this study, we present some of the difficulties with this technique encountered during the surgery or in the follow-up period that led to complications, indicating some required modifications and suggesting possible limitations of the technique.

MATERIALS AND METHODS

This study included 21 patients with burn scar contracture needing surgical release. Preoperatively, for marking the flaps for running V-Y plasty, a zigzag line, the angles of which were kept in the range of 60-90°, was drawn over the contracture line. The tip of the V's did not extend forward to the contracted tissue near the contracture line. The long arm of the Y was drawn on the relatively smooth skin that was not affected severely by the contracture, so that all of the loose tissue placed under the contracture could be used as a pedicle, which facilitated advancement of the V flap into the smooth skin area without undermining (Fig. 1a, 2a, 3a, 4a). In the operation, the incision was firstly made only into the skin to avoid retraction of the flaps, which might deform the skin marking, and then deep through the fascia, making advancement of the V flap easier by sliding. In some cases where the V flaps required more advancement to cover a large joint surface, such as the elbow, wrist, knee or ankle, the distal one-third or one-fourth of the V flap was elevated. The whole horizontally wrinkled skin in the V flap was opened and then placed on the defect area created by the incisions, and the V flap was advanced as far as possible along the long limb of the Y on the base of the subcutaneous pedicle (Fig. 1b, 2b, 3b, 4b). After meticulous hemostasis, incisions were sutured.

RESULTS

This study included 21 patients who had burn scar contracture of varying severity, whose ages ranged from 5 to 23 years. There were 11 male and 10 female

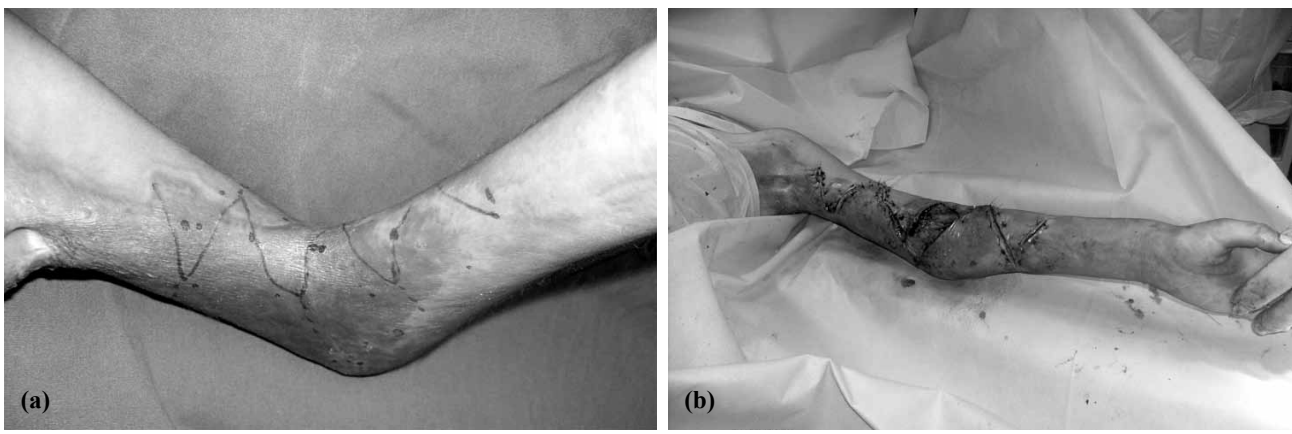

Fig. 1. **(a)** An 11-year-old boy who suffered from an early postburn contracture: Running V-Y plasty was planned for the release of the scar contracture and designed with a zigzag marking of the flaps, which continued from the proximal to the distal contracture line. **(b)** After performing incisions, the contracture was released completely without any need for undermining of the flaps, all of which were then advanced into the Y incisions, leaving an important skin defect needing skin grafting to close the wound.

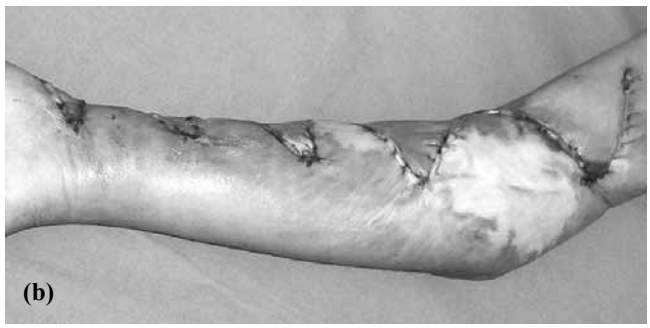

Fig. 2. **(a)** A 21-year-old woman who had sustained a severe flexion contracture on her right upper extremity involving the hand, wrist, forearm and elbow: A long running V-Y plasty was planned to release this contracture; the appearance after marking the flaps. **(b)** After all incisions were made, the contractures areas were released completely. Note the tip necrosis of the flap on the elbow and that the flaps over the wrist and elbow needed to be elevated at the tip portions to facilitate their advancement along the Y incision, which ran as a semicircle over the joint surface. **(c)** Wrinkling over dorsal thumb, which failed to resolve during the eight-month follow-up, seems to be in need of some revision.

patients and their mean age was 12.5 years old. The cause of burn was scald in 14 cases and flame burns in 7 cases. Contracture duration varied from 3 months to 9 years, with an average of 23 months (Table 1). Contractures were localized to either one anatomical area such as the neck, shoulder, axillae, antecubital area, wrist, forearm, leg, ankle, and popliteal area or to more than one anatomical area such as the cervicopectoral area, axillo-deltoid area, upper extremity from wrist to arm, or lower extremity from ankle to poplitea. In this study, no major complication such as hematoma, infection, wound dehiscence, or complete flap loss was observed. In most of the patients, successful release of the contractures was achieved without any complication or recurrence of the contractures in the follow-up period. Patients were followed regularly for 3-15 months, for an average of 6.6 months.

In a few cases, some challenging problems developed in either the early or late postoperative period, suggesting possible limitations of the running V-Y plasty procedure (Table 2). In two cases, necrosis of the V tips occurred, but healed uneventfully within one month after debridement of the dry eschar (Fig. 2b, 3b). In another patient, V flaps were insufficient to cover the antecubital defect area after releasing the contracture, so skin grafting was required (Fig. 1b). One cervical contracture relapsed at about one year after the surgery and required reoperation (Fig. 4c). In

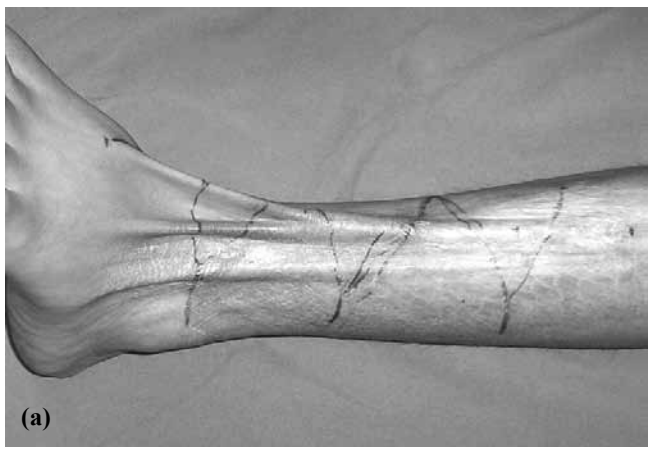

Fig. 3. **(a)** A 16-year-old girl who had suffered from postburn flexion contracture. **(b)** View of the tip necrosis that occurred a few days after surgery and healed within one month after debridement of the dry eschar. Note the tip necrosis of the next opposite flap, the wrinkles at the lower malleolar area that developed during suturing.

Table 1. Clinical details of the patients who underwent running V-Y plasty

No.	Sex	Age	Type of burn	Duration of contracture (mo)	Location of contracture	Complication	Follow-up time (mo)	Results
1	M	11	Scald	3	Elbow	Skin defect	6	Skin grafting
2	F	21	Flame	108	Upper extremity	Tip necrosis Skin wrinkles	8	Acceptable
3	F	16	Scald	96	Ankle, cruris	Tip necrosis Skin wrinkles	4	Acceptable
4	M	6	Flame	10	Neck	Recurrence	12	Reoperation
5	M	7	Flame	48	Axillodeltoid	No	15	Good
6	F	23	Scald	11	Elbow	No	6	Good
7	F	9	Scald	13	Axillae	No	3	Good
8	F	16	Scald	13	Cervicopectoral	No	7	Good
9	F	6	Scald	9	Poplitea	No	4	Good
10	M	11	Scald	16	Neck	No	7	Good
11	M	19	Scald	12	Poplitea	No	8	Good
12	M	17	Flame	12	Axillae	No	6	Good
13	M	14	Scald	13	Wrist	No	5	Good
14	F	9	Scald	11	Ankle	No	9	Good
15	M	5	Scald	15	Leg	No	3	Good
16	F	7	Flame	15	Shoulder	No	8	Good
17	F	5	Scald	16	Elbow	No	7	Good
18	M	9	Flame	17	Elbow	No	6	Good
19	F	19	Scald	18	Axillae	No	7	Good
20	M	17	Scald	14	Axillae	No	5	Good
21	M	17	Flame	13	Leg	No	5	Good

Table 2. Overall complications with occurence rates

No.	Tip necrosis	Prolonged healing	Recurrence	Need for revision	Skin defect	Total
1	No	Yes	No	No	Yes	
2	Yes	Yes	No	Yes	No	
3	Yes	Yes	No	No	No	
4	No	No	Yes	Yes	No	
Complication rate in all cases	9.5%	14.2%	4.7%	9.5%	4.7%	19%

two patients, for three joints (wrist, elbow and ankle), undermining of the distal V flap was necessary to sufficiently advance the V flap into the Y incision (Fig. 2a, 3a). Significant wrinkling was also observed on the dorsal surface of the hand in one patient who had severe upper extremity scar contracture (Fig. 2c).

DISCUSSION

Running V-Y plasty and its modifications, such as opposite running V-Y plasty and multiple V-Y plasty, are widely used techniques with similar geometric and surgical principles in the release of linear contractures, providing successful results due to the advancement of the contracture tissue into the adjacent non-contracted area. Its main advantage over the other Z-plasty procedures is protection of blood perfusion in the flap, which usually overcomes the possibility of flap necrosis and marginal vascular compromise occurring frequently in Z-plasties.[3-7] Additionally, it is a simple, adaptable and reliable method when compared with other choices for contracture surgery such as skin graft, local flaps, regional flaps, transposition flaps, rotating flaps, axial flaps, perforator flaps, and free flaps. However, it seems that there are some difficulties in particular situations, suggesting limitations that can affect the surgical procedure, outcomes, complications, and selection of the patients suitable for this technique. In the early contractures, usually occurring a few months after the burn, the contracture tissue and its surroundings are generally very hard and hypertrophic, and do not have sufficient soft and pliable tissue involving mature scar suitable for advancement as a flap to cover the skin defect developing after release of the contracture. As presented in Fig. 1, in the early contractures, it is difficult to find sufficient soft tissue around the contracture band to cover the entire wound, so contracture release with running V-Y plasty requires recruitment of skin from outside the contracture area.

Such cases are poor candidates for this technique. In a study, Lin et al.[8] presented a six-year-old patient with a contracture located on the anterior axillary line from the axillae to the lateral abdominal area. When evaluating the figures, although the patient had a mild contracture with hypertrophy and erythema suggesting an early contracture, some recurrence was observed clearly in just one month after the running V-Y plasty. It was probably largely due to early contracture formation, which requires skin grafting for complete release and to prevent recurrence.

Sufficient advancement of the V flap, which provides much more tissue for the defect area, is the most important step in the technique, resulting in complete release of the contracture without any need for skin grafting; however, in severe contractures placed over large joints such as the elbow, ankle and poplitea, which have a round and long surface, adequate advancement of the V flap may require some elevation of the tip of the V flap. If the distal flap is not undermined, the tip of the flap rolls down during the advancement, and does not move entirely into the Y incision until all the horizontal wrinkles in the flap open; therefore, even if there is enough tissue to cover the entire wound in the contracture line, the flaps can not close the defect completely without undermining. Lin et al.[8] presented a 13-year-old boy who had suffered from left axillary contracture since the age of four. He was treated successfully with running V-Y plasty, but late postoperative results as shown in the presented figures demonstrated significant recurrence, suggesting inadequate advancement of the V flaps due to the lack of the distal elevation of the flaps, although there appeared to be sufficient soft tissue present.

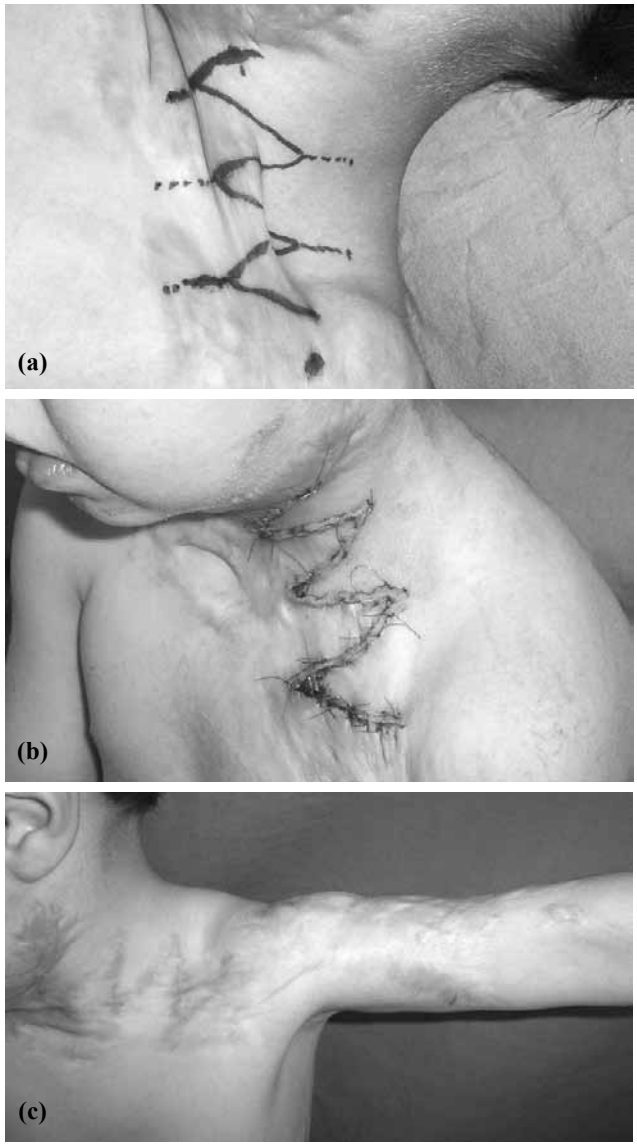

Fig. 4. **(a)** A six-year-old boy who had suffered from a severe postburn contracture on the left cervical area. **(b)** In the early postoperative period, appearance of the smooth neck surface without any signs of wrinkles. **(c)** Approximately one year later, view of the recurrence of the contracture.

Any elevation of the tip of the V flaps has an increased risk for compromising the vascular supply of the distal flap, sometimes resulting in skin necrosis, as occurred in two of our cases. At the first look, the tip necrosis in Fig. 3 seems to be caused by a long narrow flap and might have been avoided with a broader flap design; however, the next opposite flap, which was wide, similarly developed necrosis in the tip region after elevation. When dealing with this technique in releasing the contractures involving large joints, skin necrosis with undermining of the V flap or insufficient correction and recurrence without elevation of the distal V flaps is possible, whereas in releasing other types of contractures, especially those that are mild to moderate, it appears very useful and safe and does not require any elevation. van Niekerk et al.[9] presented a patient who had a short moderate contracture treated with multiple V-Y plasty, and they demonstrated successful results without any complications. Similarly, in our experience, such cases were managed successfully without any problems.

In some anatomical areas such as the neck, the technique seems to be prone to recurrence over time, despite there being sufficient tissue available for the release and closure around the contracture band. As presented in Fig. 4, during the early postoperative follow-up, no problem appeared. However, one year later, some recurrence developed that required reoperation. This may have been caused by the child's rapid body growth with poor elongation capacity of the scar tissue, but a study including a large number of patients treated with this method for neck contracture would be necessary in order to draw a definite conclusion.

When a long horizontal advancement of the V flap is made in some areas such as the wrist and ankle, the

surfaces of which are nearly round, suture lines between the V flap and healthy skin tend to bunch during suturing, resulting in wrinkles and sometimes leaving permanent deformity. As in Fig. 2, some patients may require revision surgery. This is due to length inequality between the Y incision and margin of the V flap, which becomes clearly significant when making extensive advancement. van Niekerk et al.[9] emphasized that the angles of the individual flaps of the V-Y plasty do not need to be equal and also that the angles of the Ys do not need to be equal in size. In our experience with the same V-Y plasty flap, the length of the Y incision and margin of the V should be equal, otherwise, wrinkling and bunching will inevitably develop at the suture line placed over two unequal lengths during suturing. As the discrepancy between two sides is small, particularly in mild to moderate contractures such as their presented case, it can be easily accommodated; however, in severe contractures placed over large joints, sufficient accommodation seems to be difficult without leaving skin wrinkles.

In this study, V flaps as a zigzag were placed only over the contracted tissues, and did not reach the smooth and non-contracted adjacent area, in order to facilitate the advancement of the flaps into the Y incision on the base of loose subcutaneous tissue. When compared with the other modifications of the procedure, this design of the flaps is the most important point distinguishing our technique from the others. In this method, advancement of the V flap is done by sliding using subcutaneous loose tissue, so less subcutaneous tissue is placed under healthy skin or a non-contracted smooth area covered by scar tissue or a skin graft, which can limit complete movement of the flap into the Y incision, resulting in insufficient advancement and contracture release, unless the distal portion of the V flap was elevated. The technique uses all of the excess tissue around the contracture, and requires adequate advancement of the V flap to provide successful release. van Niekerk et al.[9] emphasized that the proportional distance of flap advancement is the sole determinant of length gain as a result of mathematical calculation; therefore, effective advancement is essential for the method.

It is clear that none of the methods described for contracture release has been sufficient to provide successful outcomes in every case; therefore, selection of those patients who are suitable for each surgical procedure seems to be the most important issue to achieve complete release of contractures without development of complications. When considering running V-Y plasty for the release of contractures, one should keep in mind its difficulties as a guide to achieve successful outcomes.

In conclusion, despite its benefits, there are some difficulties in the running V-Y plasty technique, which are summarized in detail below:

1. Running V-Y plasty is most useful in linear mild to moderate contractures.

2. In severe contractures, particularly involving more than one anatomical area or joint surface, the classic procedure can be ineffective for complete release.

3. Every additional procedure, such as flap elevation, a long narrow flap design or extensive advancement of the flap, seems to carry an increased complication risk.

4. The technique cannot be applied to immature contracture bands. In such cases, one should wait for the scar maturation, or local flaps or skin grafting can be used for contracture release.

5. In the same V-Y plasty flap, the length of the Y incision and margin of the V should be equal; otherwise, wrinkling or bunching of the skin will inevitably develop at the suture line during suturing.

6. In the neck of children, the technique seems to be prone to recurrence.

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