

Use of Subcutaneous Pedicled Rhomboid Flap Technique for Surgical Treatment of Burn Contractures

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ABSTRACT

Objective: Release of contractures mainly due to burn scars mandates reconstruction with a well-vascularized tissue and an aesthetically acceptable result. Many techniques of the reconstructive ladder have been applied. Local flaps are the first choice. In this study, we present a superior local flap alternative, the diamond flap (subcutaneous pedicled rhomboid flap), for the reconstruction of contractures.

Methods: In a 1-year period, 23 patients underwent contracture release using a diamond flap. The elongation of the distance between two reference points on the contracture line was measured.

Results: A total of 23 contractures due to burn scars were released via a diamond flap in 23 patients. No flap loss was seen. Patients were followed up for an average of 18 months, and no recurrence of contractures was seen. Elongation of the contracture lines was measured as the distance between two reference points preoperatively marked. We observed 60%–200% elongation of the contracture line during early postoperative measurement and 30%–125% elongation during late postoperative measurement depending on the anatomical site and original length of the contracture.

Conclusion: Diamond flap should be kept in mind as an alternative for contracture release, especially in cases of wide, long, multiple adjacent contractures located in poorly vascularized areas.

Keywords: Diamond flap, contracture, burn, Z-plasty, local flaps

INTRODUCTION

Contractures are one of the major areas of plastic surgery. The release of contractures mainly due to burn scars mandates reconstruction with a well-vascularized tissue and an aesthetically acceptable result. Many techniques of the reconstructive ladder have been applied till date, including skin grafts, Z-plasties, local flaps, and even free flaps. Grafts are not used often because they cause secondary contracture. In contrast, free flaps are better reserved for selected cases as both the procedure itself and postoperative care is arduous. Hence, local flaps are the first choice in contracture release, among which Z-plasties are most commonly used. In this study, we present a superior local flap alternative for the reconstruction of contractures (1).

The rhomboid flap was introduced by Suzuki et al. (2) in 1987, whereas the subcutaneous pedicled rhomboid flap was first used by Uzunismail et al. (3) in 1994 for contracture release. Subsequently, Askar (4) published their modification of the rhomboid flap under the name “double reverse V-Y plasty”.

In the original article, the rhomboid flap is planned so that the 60° corner lies on the contracture line and the 120° corner lies perpendicular to the contracture line (5-7). However, in our study, we planned the rhomboid flap with 90° angles in an attempt to obtain greater release of the contracture.

Although it was described earlier, we believe that the subcutaneous pedicled rhomboid flap has not found its worth. We preferred to name this flap as “diamond flap” because of its shape and because we find it to be very valuable.

The diamond flap is a good alternative to Z-plasties for the reconstruction of large and long scar contractures. In this study, we aimed to present different uses and advantages of the diamond flap.

METHODS

Ethics committee approval was received for this study (Gaziantep University Clinical Research Ethic Committee, 07.01.2014 /8). In a 1-year period (Oct. 2013–Oct. 2014), 23 patients, including 14

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Table 1. Analysis of Results by Time

Patient	Sex	Age	Contracture localization	Preop length	Early Postop length	% of early postop gain	Late postop length	% of late postop gain
1	M	3	Antecubital	4	7	75	6.5	62.5
2	F	3	Popliteal	2	3.5	75	3	50
3	F	5	Antecubital	3	5	66	5	66
4	M	6	Axilla	3	5.6	86.6	5	66.6
5	M	8	Thumb	3.5	6.8	94	5.4	54
6	M	9	Axilla	4	7	75	6.2	55
7	M	10	Oral Commis.	1	1.6	60	1.4	40
8	F	12	First Web	6	15	150	13.5	125
9	M	13	Thumb	5	11.5	130	9.5	90
10	M	14	Antecubital	6	12	100	11	83.3
11	M	14	Axilla	7	16	128.5	13.3	90
12	F	17	First Web	3	7	133.3	5.7	90
13	F	18	Neck	3	9	200	6	100
14	M	18	Ankle	2	3.5	75	3	50
15	M	19	Antecubital	5	8	60	7.5	50
16	F	20	Neck	3	6	100	4.8	60
17	F	22	Thumb	4	8	100	7	75
18	M	23	Popliteal	3	5.5	83.3	5	66.6
19	M	25	Foot	6	13	116.6	11	83.3
20	M	27	Digit	5	9	80	5.5	30
21	F	29	Popliteal	6	13.6	126	11	83.3
22	F	29	Neck	2	5	150	3.5	75
23	M	33	Ankle	7	12.7	81.4	11	57.1

M: male; F: female

males and 9 females, underwent burn contracture release using the diamond flap. Patients' age ranged between 3 and 33 years. Informed consent was obtained from patients who participated in this study. Contracture locations and patient features are shown in Table 1. We subtracted the length of the preoperatively marked rhomboid flap (A–B) from the postoperative length provided by relaxation incisions (A_2-B_2) as shown in Figure 1. Thus, elongation of the distance between the two reference points on the contracture line was measured. Some patients had joint stiffness and were therefore referred to the physical therapy department. Patients were followed up for a mean of 18 months (12–24 months).

In its original article, the rhomboid flap is planned such that the 60° corner lies on the contracture line and the 120° corner lies perpendicular to it. Each side of this equilateral rhombus should not be longer than the contracture line. Then, two relaxation incisions are drawn externally from each 120° corner, which is no shorter than half of and no longer than one side of the rhombus. Full-thickness incisions around the flap and along the relaxation

lines are completed so that an island flap is obtained. The end-point of the relaxation incisions is pulled toward the corner of the rhomboid flap and sutured in a Y-V fashion. The 60° corners along the contracture lines are closed in a V-Y fashion (5-7). Thus, an elongation of the contracture line is obtained at the expense of lateral tissues on either side. In our series, we planned the rhombus with 90° angles in order to obtain a greater release of the contracture and eventually observed this to come off. The narrower the side angles of the rhombus, the greater the elongation in the contracture line; however, this also causes a dog ear deformity. Thus, we believe that a 90° rhomboid flap is ideal. Emphasis should be made as the incisions must be made full thickness until healthy tissue is reached, otherwise no release of the contracture will be possible (5-7).

RESULTS

A total of 23 burn contractures were released via a diamond flap in 23 patients. No flap loss was seen; however, one patient developed partial flap necrosis, which healed by secondary healing. Patients were followed up for an average of 18 months. Elonga-

Figure 1. (Above) Preoperative markings of the 90° rhomboid flap over a contracture band on the antecubital fossa. Proximal and distal ends of the flap (A–B) measured as the preoperative length of contracture band. (Below) The endpoint of the relaxation incisions is pulled toward the corner of the rhomboid flap and sutured in a Y-V fashion. Proximal and distal corners along the contracture lines are closed in a V-Y fashion. A₂–B₂ shows the early postoperative length measurement after contracture release

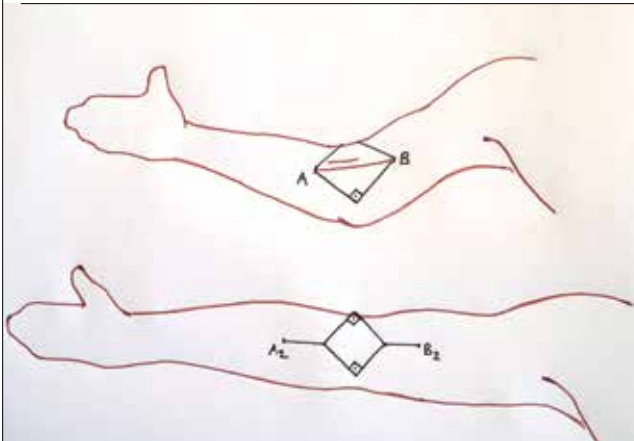
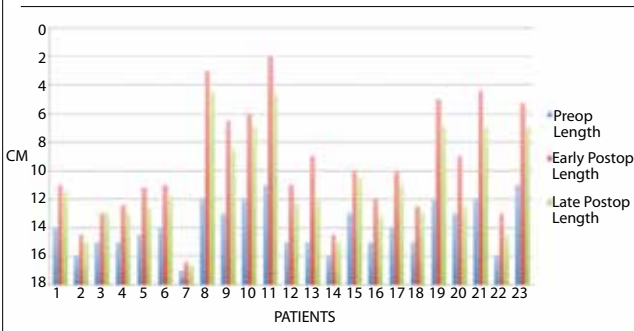


Figure 2. Preoperative, early postoperative, and late postoperative length of contracture bands of patients are shown graphically



tion of the contracture lines was measured immediately after closure and 1 year postoperatively as shown in Figure 2. Previous studies report conflicting data regarding the amount of elongation obtained with rhomboid flap. According to our results, we obtained 60%–200% elongation of the contracture line during the early postoperative measurement and 30%–125% elongation during the late postoperative measurement, depending on the anatomical site and original length of the contracture as shown in Figures 3–5.

DISCUSSION

This series includes a group of patients of heterogeneous ages, the results of whom are incomparable. There is no clear description of the locations or the size of the flaps.

Measuring only the postoperative result, only in relation to the gain of length, does not let one conclude the same growing the functional improvement of the segments operated on.

Figure 3. a-d. Preoperative planning of an 18-year-old patient with a burn scar on the neck (a), Contracture released with a 90° equilateral rhomboid flap (b), A 200% elongation distance was gained and no dog ear deformity occurred (c), Postoperative view (d)

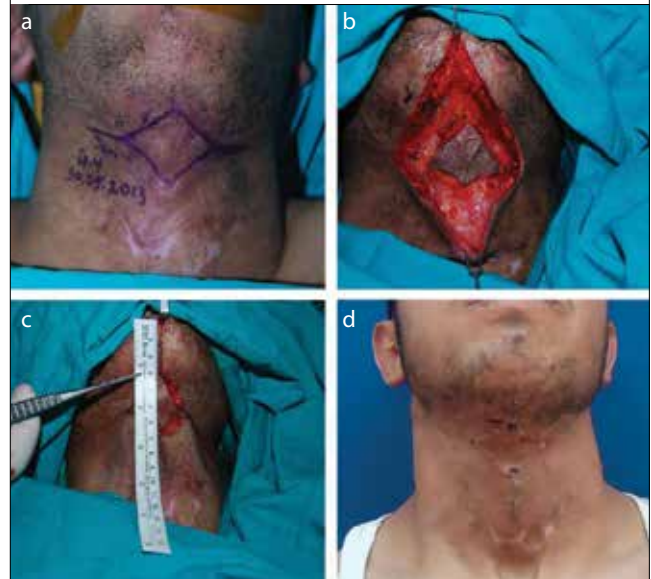


Figure 4. a-f. A 3-year-old patient with a burn contracture in the right antecubital region (a), Preoperative planning of a 90° equilateral rhomboid flap (b), A 75% elongation was gained intraoperatively (c), Postoperative view after contracture released completely with additional physical therapy (d), Late postoperative view (e), Postoperative second year; we used Z-plasties in order to change the direction of thickened scar tissue and to have a better aesthetic result (f)



There is no scientific data that compares each technique with a designated control group.

Various techniques have been used for the release of scar contractures, including split and full-thickness skin grafts (8), local flaps (9–12), and even free flaps. Grafts are not preferred as they cause secondary contraction. Free flaps, on the other hand, are difficult procedures and not cost-effective. Thus, local flaps, mainly Z-plas-

Figure 5. a-c. A 9-year-old patient with a burn scar on his right axilla (a), Contracture released with a 90° equilateral rhomboid flap (b), Postoperative view (c)



ties are the most commonly used techniques in contracture reconstruction. In this study, we aimed to offer an alternative to Z-plasty in contracture release, namely the diamond flap.

Numerous modifications of Z-plasties have been described, such as double-opposing Z-plasty; four, five, six, and seven flap Z-plasty; and unequal Z-plasty. Apart from Z-plasty, V-Y plasties and rotation flaps have also been used for the same purpose (13-18). In 2004, Ertas et al. (19) compared Z-plasty to the diamond flap on a rat model and reported 243% elongation with Z-plasty and 327% elongation with diamond flap. In the same year, they released an experimental study on rat inguinal skin, reporting a mean elongation of 139% with the diamond flap (128%–152%) (20). In other studies by the same authors in 2004 and 2006, 75%–90% and 60%–75% elongation, respectively, were reported (1, 6). Although these results are conflicting, when a single Z-plasty and a single diamond flap with equal angles are compared, consistent data show a greater elongation with diamond flap. As previously noted, we experienced that a 90° equilateral rhomboid flap is ideal at providing contracture release and avoiding dog ear deformity at the same time.

Because the flaps have to be elevated in Z-plasties, in case of a poorly vascularized bed, distal flap necrosis can occur. On the contrary, the diamond flap is subcutaneous pedicled and does not require flap elevation; thus, it may be safely used in a scartical, previously grafted and re-contracted bed (19, 20).

Z-plasties are superior to diamond flap in changing the direction of the contracture band. As shown in Figures 4f and 4g, in the postoperative second year, despite the fact that antecubital contracture of the patient totally released with the diamond flap, we had to use Z-plasty in order to change the direction of the thick scar tissue. Thus, we achieved a good aesthetic result by adding a sekonder Z-plasty after a diamond flap.

Five-flap Z-plasty was first introduced by Mustardee for the release of an epicanthal fold and was named as “jumping man” because of its shape. It was modified by Hirshowitz for web contractures. Theoretically, 75% is gained from Z-plasty and 50% from V-Y plasty, which amounts to 125% gain (21). Similar to Z-plasty, five-flap Z-plasty entails flap elevation, which may compromise flap circulation.

The first use of Y-V plasty for contracture release was described by Szymanowski in 1856 for oral commissure. In a long contracture line, Y-V plasty yields successful results. Contradictory data exist on the amount of elongation obtained, with various studies reporting 50%–100% release. In a well-vascularized, pliable bed, Y-V plasty yields greater gain compared with a 60° Z-plasty (22-24). It does not involve elevation of flaps, so flap compromise is rare. Short operative time is another advantage. However, a wide and scartical bed enables only inferior results and is not suitable for such cases.

Multiple Y-V plasties were first used by Bier et al. (25) in 1922 for soft tissue defects. Although very useful in a long linear scar, it is not feasible in wide or adjacent contracture lines.

Subcutaneous pedicled rhomboid flap, named as the diamond flap, is a simple, time-consuming flap that is easy to teach and apply. Vascular compromise is not likely as it does not involve dissection and elevation of flaps. As it is devoid of wide dissections, it can be performed under local anesthesia for adult patients. It can be safely used in two or more adjacent contracture lines, in which case it would be difficult to plan Z-plasties, Y-V plasties, or other local flaps, and flap circulation is more likely to be compromised.

Another advantage of the diamond flap is its perfect fit in web spaces. Compared with five-flap Z-plasty, the operative time is much shorter and flap circulation is much more reliable.

Finally, as there is no flap transposition, anatomic lines are less violated.

CONCLUSION

The diamond flap should be kept in mind as an alternative for contracture release, especially in cases of wide, long, multiple adjacent contractures located in poorly vascularized areas. It is easy to teach and apply but is time-consuming and expensive.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Gaziantep University (07.01.2014/8).

Informed Consent: Written informed consent was obtained from patients or patients' parents (if under 18 years old) who participated in this study.

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