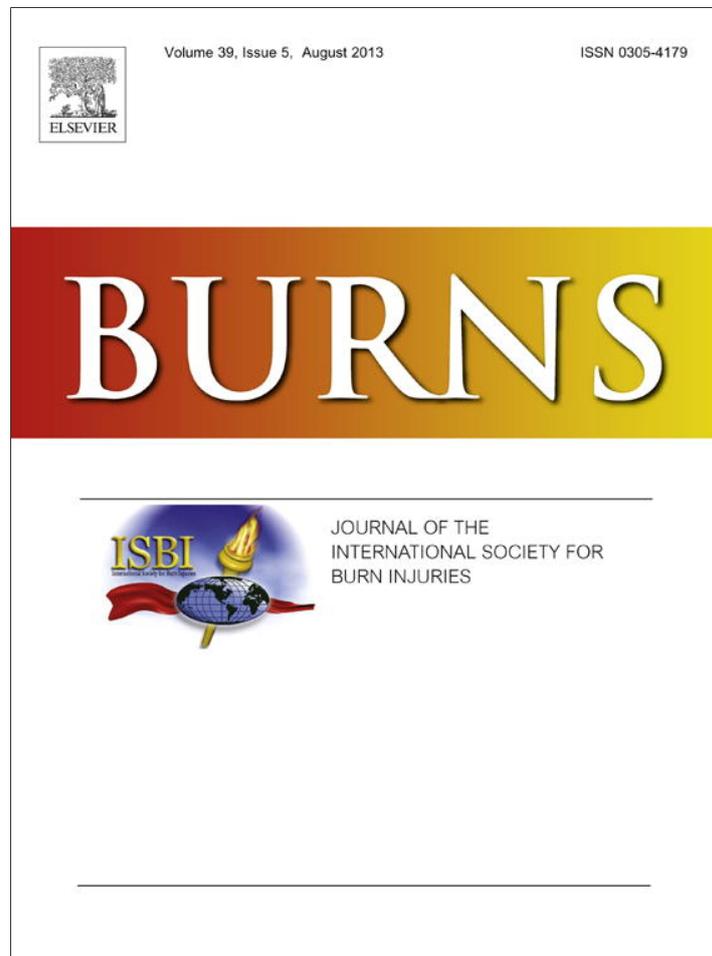


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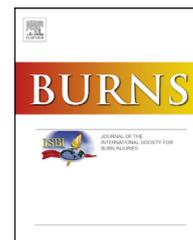
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Management of scar contractures of the hand using Z advancement rotation flap

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ABSTRACT

Functional consequences of hand contractures may lead to extreme impairment in hand functions so repair of the contractures can solve the problems related to hand functions. Different forms of z plasties have widely been used for the release of scar contractures. In this study, a useful z plasty technique, z advancement rotation flap (ZAR) was adapted for the release of hand contractures in the way of using only local tissues.

Fourteen consecutive patients who had hand contractures, were treated successfully with z advancement rotation flap technique. They suffered from hand contractures for at least one year which were localized in web spaces, flexor surfaces of the digits, first web space, palmar area and extensor surface of the hand. Contractures are all in mild severity, restricting some of the hand motions moderately.

In all patients, hand contractures released completely and clinically normal joint motions were achieved, improving extension, flexion and abduction ranges of fingers without any difficulty. All advanced and rotated flaps healed uneventfully. No major complications appeared such as infection, hematoma, suture dehiscence, flap congestion or necrosis.

When dealing with this technique for release of hand contractures, it may offer a versatile alternative to well known z-plasty methods used particularly for hand contractures.

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1. Introduction

Functional consequences of hand contractures may lead to extreme impairment in hand functions, although the hand has only 3% of the body surface area. In most cases, contracture affects some specific regions of the hand such as palmar area, volar side of the fingers, and web spaces, resulting in disabilities in those with severe deformities. However, contractures may occur in the remaining areas of the hand as a sole contracture or in combination with the other contractures. Many contracture deformities of the hand

frequently develop after burn, whose surgical repair including release and defect closure steps is a challenging problem because of the paucity of soft tissue nearby the contracture area. Poor functional outcome and high rate of recurrence are not rare in daily clinical practice [1].

Many kinds of reconstructive methods have been used to treat severe hand contractures effectively. After the release of the contractures, skin grafting and flap choices provide successful coverage of the skin defects especially in complex postburn hand contractures. Regional flaps, transposition flaps, rotating flaps, axial flaps, perforator flaps and free flaps may effectively cover the skin wounds arising from

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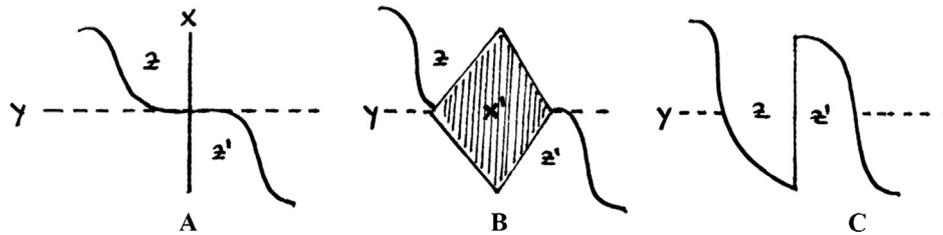


Fig. 1 – Schematic design of the ZAR flap. (A) Y represents contracture band, X relaxing incision line. Z and Z¹ shows flaps. (B) X¹ illustrates the area arising from contracture release later the relaxing incision. Note that this area is in rhomboid shape. (C) Z and Z¹ flaps, namely ZAR flaps, are rotated and advanced into the defect area, providing a considerable elongation in the contracture line.

contracture release, but many of which have some drawbacks such as necrosis, donor site morbidity, long operation time, and difficult surgical dissection [1,2]. For mild to moderate contractures, z plasties and local flaps may be considered to be the best choice in the treatment, providing a good release and defect coverage without needing complex surgical procedures [3,4].

Different forms of z plasties have widely been used for the release of scar contractures. In this study, a useful z plasty technique, z advancement rotation flap (ZAR) was adapted for the release of hand contractures in the way of using only local tissues, providing effective contracture release, easy postoperative wound care, early range of motion and hand therapy.

2. Materials and methods

A clinical study was designed for this trial in which fourteen consecutive patients who had hand contractures, were treated successfully with z advancement rotation flap technique. Pattern of the study was a retrospective review. Patients suffered from hand contractures for at least one year which were localized in web spaces, flexor surfaces of the digits, first web space, palmar area and extensor surface of the hand. Contractures are all in mild severity, restricting some of the hand motions moderately and needing surgical release to relieve restriction of the finger motions completely. As they

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 and Renshaw [5]. Burn was the main cause of the contractures in 13 cases and skin defect due to traffic accident was the cause in one case.

As z advancement rotation flap was originally described for the coverage of the rhomboid shape skin defects, it was considered that contractures that could leave a rhomboid shape wound after the surgical release, were suitable for this procedures (Fig. 1). Any contractures which seemed to have the possibility of leaving another wound shape later the contracture release, were excluded from the study.

3. Results

In this study, fourteen patients underwent the contracture release procedure, whose ages ranged from 8 to 21 years, with nine male and five female patients. Mean age was 12.3 years. None of the patients had undergone any intervention for the release of contracture before. We utilized this z plasty technique to treat 19 hand contractures of 14 patients (Table 1). All contractures were released completely without any skin grafts or additional z plasties and local flaps. After achieving regional or general anesthesia, the hand was prepped, draped, and exsanguinated with an esmarch bandage. A tourniquet

Table 1 – Detailed information about the patients.

Case no.	Sex	Age (years)	Type of contracture	Involved area	Type of injury	Follow up (months)	Complication
1	M	14	Flexion	1st wep	Traffic accident	8	No
2	M	12	Flexion	Finger	Burn	12	No
3	M	8	Flexion	Palmar	Burn	11	No
4	M	16	Flexion	Finger	Burn	12	No
5	M	10	Wep	2nd and 3rd wep	Burn	9	No
6	M	18	Flexion	Palmar	Burn	15	No
7	M	13	Flexion	2nd and 3rd finger	Burn	11	No
8	M	9	Flexion	Finger	Burn	8	No
9	M	10	Flexion	1st wep	Burn	10	No
10	F	15	Extension	Hand dorsum, finger	Burn	15	No
11	F	9	Flexion	Finger	Burn	11	No
12	F	10	Wep	3rd and 4th wep	Burn	6	No
13	F	21	Wep	2nd wep	Burn	7	No
14	F	8	Flexion	4th and 5th finger	Burn	3	No

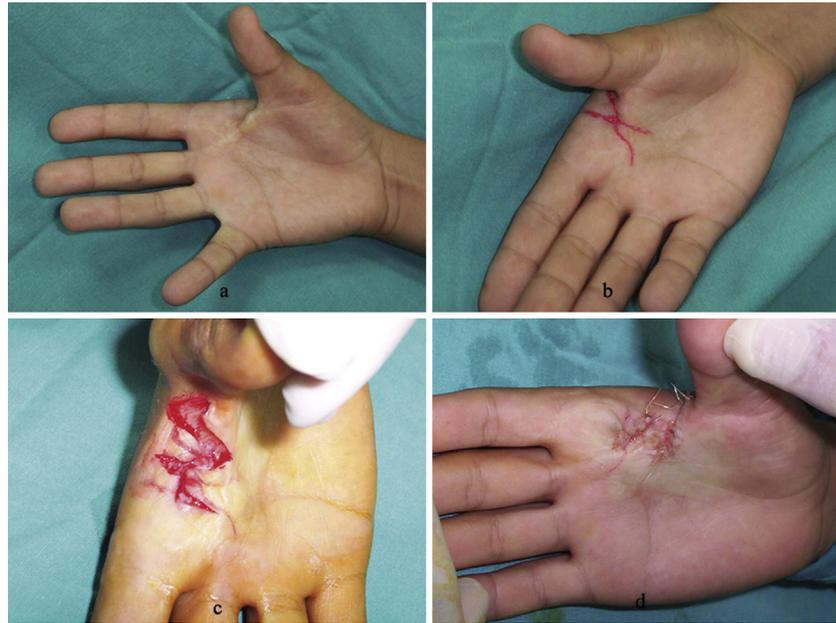


Fig. 2 – (a) Preoperative view of a first web space contracture of the right hand. (b) A central relaxing incision and Z-plasty flaps were marked on the contracture band. (c) Intraoperative view of the first web space with the ZAR flaps giving a full release of the contracture. (d) Immediate postoperative result.

was placed to the upper extremity and kept in place until the dressing was applied at the end of the intervention. Prior to the surgery, a z-advancement rotation flap combined with a relaxing incision line was marked on the contracture band (Figs. 2–5). While limbs of the z were being placed lateral to the contracture line, relaxing incision line was drawn just over the contracture area, perpendicular to the contracture line, being capable of providing a complete release. Length and width of

the limbs of the ZAR flap were planned according to the need of flap size which would cover the skin defect arising from the released contracture line. After the marking was completed, firstly contracture band was cut transversely and sufficient contracture release was achieved, leading to a wound which was in rhomboid shape. Then, both limbs of the z flap were incised on the lateral sides of the rhomboid defect. Tips and margins of the limbs were elevated a few millimeters from the

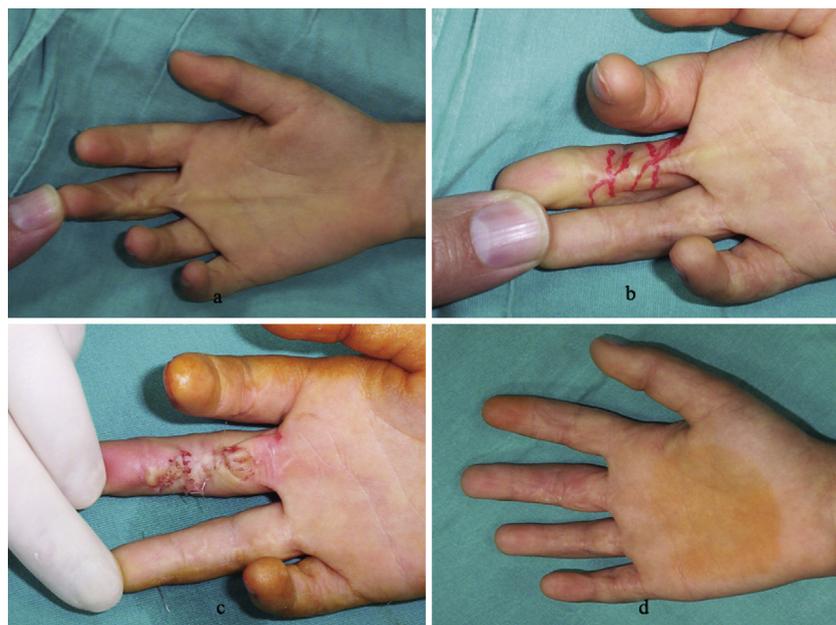


Fig. 3 – (a) Preoperative view of a finger flexion contracture. (b) Marking of the relaxing incision and ZAR flaps. (c) Immediate postoperative result. (d) Nine month postoperatively.



Fig. 4 – (a) Preoperative view of a dorsal hand contracture. (b) Early postoperative appearance. (c) One week later. (d) One year postoperatively.



Fig. 5 – (a) Preoperative view of a fourth web space contracture. A central relaxing incision and Z-plasty flaps were marked on the contracture band. (b) Intraoperative view of the web space with the ZAR flaps giving a full release of the contracture. (c) Immediate postoperative result. (d) One month postoperatively.

deep tissue with sharp dissection, which would facilitate advancement and rotation of the flaps into the defect over subcutaneous pedicle. After the 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 (Figs. 2–5). Static

splinting was applied to the hand just after the contracture release in the operation and continued within 10 days. Afterwards, hand motions and therapy sessions started.

Intraoperative mobilization of the limbs of the z was quite simple and easy, giving maximum release of the contracture line. No major complications appeared such as infection, hematoma, suture dehiscence, flap congestion or necrosis. All advanced and rotated flaps healed uneventfully. On the

postoperative examinations, it was observed that in all patients, hand contractures released completely and normal joint motions were achieved, improving extension, flexion and abduction ranges of fingers without any difficulty (Figs. 2 and 5). No recurrence of the contracture was observed in the follow-up period which was at least 3 months and varied between 3 and 15 months. The mean follow-up time was 9.8 months. Neither compression garments nor silicone gel sheeting was used postoperatively to soften the incision scars and to prevent hypertrophy; however, hypertrophic scar contractures resolved and hard scars consistently became softer after the intervention possibly due to changes in the direction of the contracture lines and considerable decrease in the tension of the contracture bands (Fig. 3). Surgical scars seemed to be acceptable in all cases.

4. Discussion

Many forms of z plasties have been described and widely used for the treatment of hand contractures. Apart from the well known 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 another less commonly used variations [6-17].

The ZAR flap is another kind of z plasty, which was first described by Pate for the coverage of rhomboid skin defects [9]. However, it has not used widely in clinical practice up to now and it has never been reported for contracture release. As well known, all Z-plasties require transposition of the flaps; however, in the ZAR flap technique, flaps make significant advancement and little rotation, so the name of 'Z' may be considered to be incorrect for these movements of flaps.

Vartak described an X-plasty technique for partial coverage of joints after release of the contractures of the fingers. Their 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 [10]. In our 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 needing skin grafting. V-N plasty is a technique for the release of severe postburn contractures of the web spaces by using tissues in the web space as local flaps to avoid using skin grafts or distant flaps [11]. 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 contracture band. However, technique is in need of adding multiple z plasty procedures to the rest of the contracture band such as a five-flap plasty; otherwise, it is not enough to release a contracture band and cover a contracture defect. In our presented method, there is no need for additional z plasty procedures and skin grafting because of the broader flap design which uses more local tissue effectively.

Rhomboid incision is an effective way to release scar contractures, which was firstly used by Uzunismail for the moderate flexion contractures of the fingers. In his study, after the contractures were released by using rhomboid skin

incision, lateral relaxation incisions were made to reduce the tension of the contracture sufficiently and then wound was closed in V-Y and Y-V fashion, without making any undermining, elevation, rotation or advancement of the rhomboid skin island [12]. 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, so there is a strong possibility to occur recurrence because of the wound contraction in the healing period. In our approach, no linear scar is left over the contracture band and contracture line is broken by the flaps, reducing the recurrence risk.

Grishkevich presented a new method of finger contracture reconstruction, trapeze-flap plasty for the treatment of flexion contractures of fingers. The oppositely transposed flaps fully or partially covered the wound in the proximal interphalangeal zone and the remaining smaller wounds were covered with full-thickness skin grafts. Scar contractures were satisfactorily addressed in all patients [6]. In our technique, wounds arising from contracture release are covered by using only flaps, so there is no need for additional skin grafting.

The 5-flap Z plasty has been originally described by Hirshowitz for the lengthening of thumb web contractures and then used in the management of flexion contractures of the digits. The geometric design of this type of Z plasty makes it suitable for the rearrangement of the limited amount of skin available in these fingers [13]. Apart from our study, this approach needs more incisions and surgical dissection.

We adapted ZAR flap technique for the treatment of postburn contractures of hand by adding some modifications to the flap design to achieve more safe and useful contracture release. As ZAR flap was described mainly for the coverage of rhomboid defects, contractures which could leave rhomboid wounds after relaxing incision, were considered to be suitable for this procedure. It provided effective release and coverage in mild contractures of the hand. It breaks the contracture line, changes the direction of contracture band and relaxes the web spaces, so that it can significantly reduce recurrences rate of contractures. Additionally, flap incisions relax the scar tissue around the contracture band, resulting in more effective release in contracture tissue. Apart from the another z plasty techniques, these flaps do not need any elevation for the movement so its blood supply does not compromise, making the flaps safer. This is very important in avoiding tip necrosis of z plasty flaps. In this study, no necrosis appeared in the z plasty flaps and all flaps have survived totally with a very good functional outcome.

We consider that the use of this technique for the release of hand contractures may offer a versatile alternative to well known z-plasty methods described particularly for hand contractures.

Conflict of interest statement

There is no conflict of interest. Neither of the authors has any financial interests, commercial associations, or other affiliations which may pose a conflict of interest to disclose. Furthermore, this paper was not supported by any external

funding, nor were any special products, devices, or drugs used in the work presented.

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