

**ARTICLE**



# Release of Wide Post Burn Contracture of Joints Using Central Axis Propeller Flap

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## Abstract

**Background:** Post burn contractures of joints can produce significant impact on quality of life by interfering with the ability to perform activities of living. Varieties of techniques are available for coverage of defect following contracture release. A Central axis propeller flap a strategy that used in patient with contracture deformities. It's a reliable method of reconstruction in release of axillary, elbow and popliteal region of knee joints contractures. **Aim:** evaluate of central axis propeller flap in wide joints post burn contractures release. **Patients and method:** Between October 2017 to May 2019 ten patients with wide joints post burn contracture ,their age range between(10-45)years .A central axis (propeller)flap based on random sub dermal pedicle of two design was used (rhomboid design for eight patients and Namaste design for two patients) by designed and elevated as a “propeller,” and then rotated by 90° to straddle the defect after contracture release. **Result:** Good functioning result in all patients indicated by good range of motion in affected joints and no serious complication ,only one case of superficial epidermal sloughing were managed conservatively. **Conclusions:** Central axis propeller flaps are reliable methods for surgical management of post burn contractures with good range of motion .However it used scary tissue ,a result appearance is cosmetically acceptable for those patients ,when the functions the primary concern. **Key Words:** Burn, postburn contracture, central axis propeller flap

## 1 | INTRODUCTION

One of the most devastating injury that person can sustain and yet hope to survive is the extensive burn. It is very common problem and in united state burn injury can occur every half hour. Because of the emergency treatment of burn and success measure in burn care the survival rate had increased. The challenge is that most of those patients who survive the extensive burn had multiple functional and

aesthetic problem. The most devastating functional problem that can be encountered is post burn contracture.(1),(2),(3),(4)  
Postburncontracture prevention can be primary with aiming of reducing incidence of burn. Secondary prevention is by promoting adequate first aid practice to reduce severity of burn. Tertiary prevention is by allowed uncomplicated burn wound healing bt early

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Supplementary information The online version of this article contains supplementary material, which is available to authorized users. Dr. Rabaab Abass Hasan, 2024; Published by MEERP , Inc. This Open Access article is distributed under the terms of the Creative Commons License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

primary wound excision and grafting. Using of splint and physiotherapy can be greatly contributed to reduce burn contracture.(5),(6).

Surgical management of burn contracture should be undertaken once the scar become mature which often occur 2 year later, of course except in critically anatomical area for example lower eyelid ectropian, in this situation early intervention should be done. Surgical release of the contracture is done either by excision or incision. When the contracture is release, the wound coverage could be done by full or split thickness skin graft, interposition skin flap. a combination of interposition flap and skin graft, muscle flap or free skin or muscle flap.(7),(8)

In this study we evaluate using of central axes propeller flap for management of wide post burn contractures.

## 2 | PATIENTS AND METHODS

Between October 2017 to May 2019, in this prospective study ten patients (6 female versus 4 male) were presented to us with history of more than one year post burn contractures at axilla, elbow and popliteal region of knee joints. Patient's age were ranging between (10-45 years), were presented to outpatient clinic of Gassi Al Harrery high specialized teaching hospital, Al-Wasity teaching hospital and Al Karkh general hospital.

Those patients were surgical treated by using central axis propeller flap (**the flap is designed and elevated as subcutaneous pedicle flap and rotated by 90° to straddle the area after contracture release**).

We excluded those patients who had

1. Immature active scar,
2. Those patient who had previously failed surgical intervention,
3. Linear scar,
4. Stiff joint and
5. Those patients whom seek aesthetic results rather than functional results.

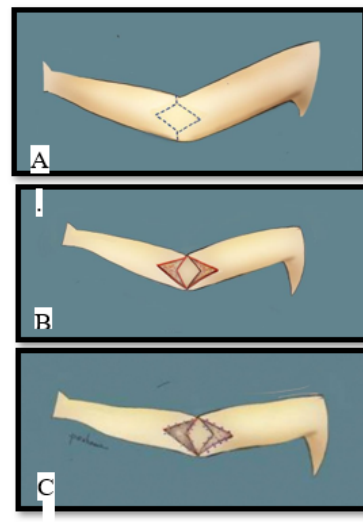
Preoperatre assessment was done for all of the patients including. The site of scar, dimension of scar, thickness and pliability of scar tissue ,angle and range of motion of joint in cases of post burn contracture involve the joint.

Those patients were sent for x-ray. All patents were subjected to routine preoperative investigation including Hb level, bleeding profile and virology screen.

Photographs were taken and preoperative informed consent obtained from all of patients involved in this study.

### Operative technique:

All operations were done under general anesthesia and no used of tourniquet. After sterilization and draping, the operation began by marking the flap, first we exert maximum tension on the scarred tissue by hyperextended the contracture band so that we can delineated the borders of scarred tissue. After that we started marking the desired flap over the scarry tissue. We had used two designs of flap, in majority of cases we used rhomboid, and Namaste designs. For rhomboid or diamond shaped design, we marked diamond shaped flap along the axis of contracture, with slits marked medially and laterally that incised at contracture release, we usually choose this design for mild to moderate contracture.

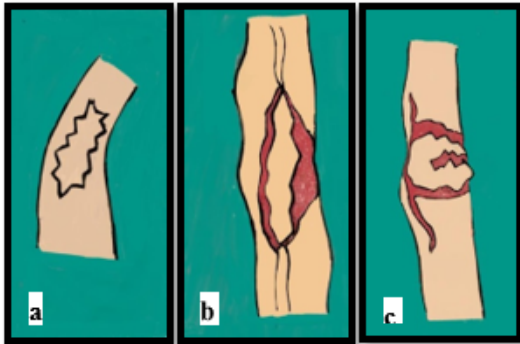


**Figure 1:** A schematic illustration of the rhomboid propeller flap design for right elbow contracture. a :The flap is designed in the center of the cubital fossa along the axis of the arm. b: After the release of the contracture, the flap is raised and rotated 90°, like a propeller. c: The donor area is covered with a skin graft.

Namaste design was used for mild contracture less than 5\*5 cm. Namaste designed done along the long axis of contracture. The width of flap will be measured so that it equal to half of the defect, their limb's length is more than long axis of the defect by more than 1 cm. the flap raised using zig-zag

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incision and their limbs are rotated by 90° at the same direction



**Figure 2:** A schematic illustration of the Namaste flap design for right elbow contracture. a) zig-zag flap outlined for elbow contracture. b) contracture release and flap dissection. c) Two limbs of flap are rotated in the same direction by 90° and Flap is inset with primary closure of donor site.

Whatever the design of flap which was used, the operation began by incision the border of the flap (over the scarry tissue) using No. 15 blade, the incision is gradually deepened until we reach the healthy fascial tissue below the scarry area then by using blunt scissor, we dissected the flap from its periphery toward its center, keeping adequate thickness of flap. The flap is designed to be based on central subcutaneous perforator pedicle which is keep attached to the central of the flap where our dissection is keeping away from its so that no injury to its blood supply. Then the limbs of propeller flap is elevated, keeping then attached to central pedicle.

After ensuring that the flap had adequate blood supply, the limbs of propellers flap are rotated as in case of rhomboid either clockwise or anti clock wise, the two limbs of propeller flap then straddle along the horizontal defect that slit laterally and medially which created after contracture release when the propeller flap is elevated two limbs of flap are fixed in their new position by using half buried 3/0 prolene suture.

Donor site were covered by using split thickness skin graft taken from the thigh, the graft fixed to its bed using s/o or stapler with tie over. Of course before fixation of flap and the skin graft, adequate hemostasis is ensured by using bipolar cautery. In these case were Namaste design is used, same operative method is undergoes ,f ollowing release

of the contracture, the central axis flap is designed along the long axis of the extremity, but flap is raised with two limbs by zig-zag incision flap are rotated go in the same direction of defect and sutured to each other using 3/0 prolene suture, the donor site in this design is usually closed primarily without using skin graft.

After finishing the operation, dressing is done using of antibiotic impregnated gauze as first layer, then dry gauze as a second layer; the dressing is secured in its position using creep bandage. For those cases where the contractures occur in limb, we used back slab for 1-2 week in order to keeping limb in extension position and avoiding movement so we secured complete graft intake. Patient discharge on next day after operation and the flap is monitored through window made in dressing. The patients kept on injectable third generation cephalosporin for one week, then converted to oral antibiotic for another week. Sutures removed at 14 day post operation and slab kept just for 1-2 week. Patients were instructed to mobilized the area at 21 days postoperatively and keep them on regular follow-up period up to 6-12 months postoperatively.

## 3 | RESULTS

In this study ten patients were presented to us with history of post burn contracture at different site of their bodies. Those patients were surgically treated using propeller flap of two design as shown in table -1- below.

**Table.1:** scar dimension, flap design, need skin graft and postoperative complication.

| Patients number | Site of contracture | Scar dimension | propeller flap design | Graft need | Complication                    |
|-----------------|---------------------|----------------|-----------------------|------------|---------------------------------|
| 1               | Popliteal           | 13X9cm         | Rhomboid design       | +          | none                            |
| 2               | Popliteal           | 8.5X7.5cm      | Rhomboid design       | +          | none                            |
| 3               | Elbow               | 15X10cm        | Rhomboid design       | +          | none                            |
| 4               | Elbow               | 12X9cm         | Rhomboid design       | +          | none                            |
| 5               | Popliteal           | 5X4cm          | Namaste design        | -          | Superficial epidermal sloughing |
| 6               | Elbow               | 13X10 cm       | Rhomboiddesign        | +          | none                            |
| 7               | Axilla              | 14X9.5cm       | Rhomboid design       | +          | none                            |
| 8               | Popliteal           | 5X4.5 cm       | Namaste design        | -          | none                            |
| 9               | Elbow               | 11X7.5cm       | Rhomboid design       | -          | none                            |
| 10              | Axilla              | 10X7 cm        | Rhomboid design       | +          | none                            |

All patient had adequate coverage of their raw area that created after contracture release with



achievement of good range of motion in comparison with preoperative function and increase in the angle of joint when comparison with pre-operative angle after contracture release as show in table -2- below.

Table.2. pre-and post-operative joints angles

| Patient number | Site of contracture | preoperative joint angle | post-operative joint angle | Angle gain |
|----------------|---------------------|--------------------------|----------------------------|------------|
| 1              | Popliteal           | 122 <sup>o</sup>         | 175 <sup>o</sup>           | 53         |
| 2              | Popliteal           | 120 <sup>o</sup>         | 170 <sup>o</sup>           | 50         |
| 3              | Elbow               | 115 <sup>o</sup>         | 165 <sup>o</sup>           | 50         |
| 4              | Elbow               | 130 <sup>o</sup>         | 170 <sup>o</sup>           | 40         |
| 5              | Popliteal           | 160 <sup>o</sup>         | 178 <sup>o</sup>           | 18         |
| 6              | Elbow               | 125 <sup>o</sup>         | 170 <sup>o</sup>           | 45         |
| 7              | Axilla              | 110 <sup>o</sup>         | 165 <sup>o</sup>           | 55         |
| 8              | Popliteal           | 150 <sup>o</sup>         | 175 <sup>o</sup>           | 25         |
| 9              | Elbow               | 122 <sup>o</sup>         | 178 <sup>o</sup>           | 56         |
| 10             | Axilla              | 130 <sup>o</sup>         | 170 <sup>o</sup>           | 40         |

All cases had smooth postoperative course with no flap necrosis or skin graft failure. Only one patient had superficial epidermal sloughing which was resolved spontaneously with conservative measurement.

All patients reported very well improvement in range of the movement and they regarded the operation gained them satisfactory improvement in range of motion in comparison with preoperative movement.

No recurrence of contracture was seen in all of our patients, and no hypertrophic scar was noticed whether at site of contracture release or at the donor site of skin graft.



Figure 3: case no.3 A) Post burn contracture of Lt elbow joint. B) and C) preoperative markings. D) release of contracture and flap dissection.E) Elevation of flap .F) Flap rotated 90<sup>o</sup> and inset. G)Donor areas being covered with STSG. H) after 10 months follow up.

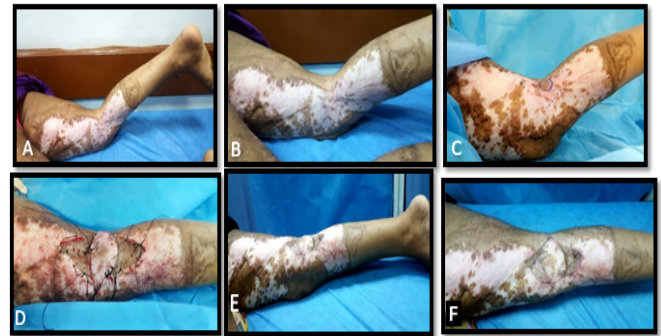


Figure 4: case no.1, A) and B) Post burn contracture of Rt popliteal region ,pre-operative pictures. C)pre- operative marking. D)Flap inset with STSG for donor sites. E)and F)after 10 months follow up.



Figure 5: case no.9, A) and B)post burn contracture of Lt elbow joint pre-operative pictures. c)after flap inset with primary closure of donor sites proximally and Z plasty flap distally. D)after 1 year follow up.

#### 4 | DISCUSSION

There are many surgical method had being used for treatment of post burn contracture these included surgical excision or incision and resurfacing with skin graft, skin substitute, or flaps whether local, distance or free flap.

In this study we used central axis propeller flaps for treatment of post burn contractures at different site of the bodies. There are increase in the angles of joint when comparison with pre-operative angle after contracture release and all of our patients had satisfactory and effective release of contracture with very good improvement in motion when it compared with preoperative movement. All the flaps were survive with no reported case of complete flap necrosis, nor skin graft loss. Only one

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patient had superficial epidermal sloughing of the flap which was not affected his final outcome and this let us to work with this method without much fear from necrosis of a part of flap and if this happen we will be involved directly in the prevention of contracture in contrast to these neglected cases which already end with contracture. In patient case no.9 post burn contracture of elbow joint after flap inset no needed for skin graft with primary closure of donor sites proximally and Z plasty flap distally this yield good aesthetic result in addition to functional result after contracture release. During follow up period which was extended up to 12 month, post operatively ,we didn't encountered any case of recurrent contracture as skin grafts cover areas adjacent but not the joints their self, and all of our patient required no long term splint (we used splint just for 2 week to ensure adequate skin graft intake). Our results are in general consistence with Gurcan Aslan et al. (9) were they used propeller flap for post burn elbow contractures in seven patients and their results showed adequate postoperative extension with acceptable cosmetic result, and no reported cases of flap necrosis. In this above mentioned study, they used propeller flap in just single design i.e rhomboid design, while in our study we used other modalities of propeller flap namely Namaste design. In addition to that in Gurcan aslan et al. study, they used propeller flap for management of post burn elbow contracture only, while in our study we used it at axilla,elbow and popliteal region of knee joints with smooth results.

Suzuki et al., was the first who introduced the principle of using subcutaneous pedicle flap that had being used for management of post burn contracture later on, and in 1994, Uzunismail was the first who used subcutaneous pedicle rhomboid flap for correction of post burn contracture in the digit and in first web space. A propeller can be described as island flap that can covered the recipient site through 90° axial rotation whether clockwise or antilock wise, According to this above concept, every skin flap can be become propeller flap if can reach the recipient site through axial rotation, while those flap that cannot become completely islanded or those who move to recipient through rotation or advancement cannot be regarded propeller flap (10).

Hyakasoku et al. was the first who introduced the concept of propeller flap in 1991 which was used of scarry tissue as flap in release of post burn elbow

contracture. Hyakusoku et al. used propeller flap for axillary and elbow post burn contractures, the original design of the flap was of two lobes, further modification was introduced in the design of flap with including more limbs as for example pin – wheel flap and multilobed flap (11), since according to Hyakusoku et al. there always constant perforator pedicle that are located along the joints, these subcutaneous perforator pedicle is preserved at the center of the scarry tissue during dissection, thus it ensure predictable flap viability. Incorporation of muscle or facial layer in skin flap design especially in burned scar, further expanded the scope of post burn reconstruction as more burned scarry tissue can be used for flap fabrication that can be used as autologous flap coverage after scar contracture release (9),(10),(11),(12).

In original work of Hyakusokue et al. the propeller flap was fabricated from intact unburned tissue, further modification proved that there is no specific problem when the scar tissue is utilized to fashion a local flap that can be used to reconstructed the defect which created after contracture release (13), (14).

Many modification had being attempt to change the design of the original propeller flap, like for e.g. multilobed, pin wheel, zig – zag incision and multiple rhomboid flap. All of these modifications are aimed to reduce using of skin graft for donor site of the propeller flap. However, these modification can prevented using of skin graft for donor site, but its applicable for mild post burn contracture release. Skin graft still used when these modifications are used for moderate to severe post burn contracture as it was showed in our study.

One of the modification of the propeller flap is the eight – limb modified propeller flap, which was used by Husam Hosny et al. in eight patient with post burn contracture involving the elbow and 1st web space. In this modification eight lobe that is triangular in shape is used, the distance between summit of each lobe will be slightly longer than the length which calculated to compensate the shortening that may occur when the flap is rotated. The main idea is to make the flaps rotated 45° instead of 90° so that it reduced the chance of vascular twisting and also reducing the need for skin graft as some donor site is closed in V-Y fashion (11).

Perforated pedicle propeller flap had being introduced, it based and skeletonized on single

perforator, it required Doppler identification of perforator vessel, and the main benefit of this modification is increased the arc of rotation of the propeller flap to be reach between 90° and 180°. (10) Using of skin graft to resurface the joint after scar excision is associated with many problem. It need prolong period of splintage physiotherapy, and they are proved to contraction that may lead to recurrence of the contracture. In addition to donor site problems. Using of flap for resurfacing of raw area after post burn scar excision required short term splint and no postoperative physiotherapy, and the flap usually grow with age especially in children(15). The main obstacle of using of local flap was the unviability of local flap because of scary area, but with introducing of concept of scarred propeller flap, this introduce a new era in post burn reconstruction.

In past several years, artificial dermal substitute had being used for post burn contracture release e.g. alloDerm™ Integra™. It technically easy to used Integra for resurfacing of joint after scar excision but it seem to be demanding procedure in term of postoperative compliance and rehabilitation. Also it had disadvantage of donor site morbidity, and the chance of split skin graft intake is lower when compared with autograft. In addition to its costly and need intensive and meticulous dressing. In small series of management of post burn contracture of neck by using Integra, Hunt et al. found all of his patient were developed recontracture (7),(8),(14).

The reverse medial arm flap (RMAF) is one of the method which had being used of soft tissue coverage of elbow after post burn contracture release however, it had limited skin dimension paddle, confusing anatomy, and the major drawback of using of this flap is venous congestion which may lead to flap necrosis. Reverse lateral arm flap had being also used for elbow soft tissue coverage after post burn contracture release. This flap had constant pedicle and straightforward in the dissection. However, it associated with sensory deficient due to injury of posterior cutaneous nerves of forearm and arm which was reported to be remain unchanged in 59% of the patients (15),(16).

One of the mostly used procedure in plastic surgery is z-plasty it is of particular value when be used for treatment of linear scar. However, it cannot be used for wide scar contraction release. One of the variant of z – plasty that have being used by Lu Zhang et al. is reversed z-plasty that used to release wide scar

contracture. However, this procedure is not effective when the contracture is very severe, since it leave a large defect after releasing of contracture. Same is applied for double combined z-plasty which is introduced by Takatoshi Youtsuyanagi et al. (18),(17)

Subcutaneous rhomboid flap had being shown to be effective in surgical treatment of post burn contracture as it have proven by Ertas et al. However the major disadvantage of using of rhomboid subcutaneous flap is donor site defect that tend to occur along the longitudinal axis of contracture with is usually closed with V-Y advancement. This might lead to formation of linear scar that tend to be reoccur later on. Multiple rhomboid flap lead to unnecessary scars which damage the delicate neighboring anatomical units and increase the incidence of contracture recurrent rate (19).

Although tissue expander promoted another option for management of post burn contracture, it had high failure rate reach up to 24%. These complications included expander infection, exposure, implant failure, flap ischemia, in addition to minor complication like seroma, intolerance for injection, and poor compliance (12).

## CONCLUSION AND RECOMMENDATION

Central axis propeller flap is proved to be easy to design and simple to applicate, it single stage operation that can be used effectively for surgical management of post burn contracture by using flap over joints rather than skin graft without scarifying a major artery or muscle. It showed to be effective in management of mild to moderate post burn contracture with excellent return of motion and with no recurrence rate however since it used scary skin it had poor aesthetic result, thus it selected for those patient when primary concerned is return of the normal function. However, a large number of patient and longer follow up period is needed to ensure the versatility of this technique.



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