Journal of Population Therapeutics & Clinical Pharmacology

Efficacy & functional outcome of supraclavicular flap and skin grafting in post burn neck contractures: a randomized controlled trial

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Abstract:

Background:
To study the efficacy & functional outcome of skin grafting to supraclavicular artery flap by evaluating donor-site morbidity, patient satisfaction, functional improvement and complications in reconstruction of post-burn neck contractures.

Methods:
In this randomized controlled trial, a total of 50 patients were included. For purpose of study patients were divided into 02 groups, group A including patients who underwent SG after contracture release for post burn neck contracture, while group B including patients with SCA flap for neck contracture, of whom in 6 patients islanded SCA flap was done, while rest of 19 patients underwent pedicled SCA flap. The study was carried out at plastic surgery department, LUH, Hyderabad over the course of 02 years from July 2021- June 2023.
In cases of patients with severe post burn neck contracture, release was first done under L.A and patient was then subjected to G.A & SG or SCA flap was done.

The patients were subsequently followed at 03 months, 06 months & 01 year postoperatively to evaluate the range of neck motion & postoperative improvement in neck extension with documentation of patient satisfaction based on Stanford-Resurge burn scar contracture scale.

Results:
With the exception of 05 pedicled flaps that had marginal tip necrosis, all flaps survived. When comparing SCA flap to SG, patient satisfaction was significantly higher for both the functional and aesthetic results. Additionally, recurrence rates were higher with skin grafting than with supraclavicular artery flap.

Conclusion:
The preferred method for reconstructing post-burn neck contractures is SCA flap, provided that donor site is available.

Key words:
Supra-clavicular artery flap; Split-thickness skin graft; Neck contractures; Outcome; RCT; Neck extension; aesthetic improvement.

1. Introduction:

After vehicular accidents, burn trauma is the second most common cause of trauma related deaths, in both developing and developed countries, affecting a patient's quality of life by reducing their ability to perform daily activities. Reconstructive surgeons face a daunting challenge when reconstructing the neck because of its multidirectional and complex motility. Serious impairment of function and deterioration of aesthetics can be attributed to neck contractures, moreover the neck's range of motion may be restricted and the lower face may function abnormally if there are scars in this area, such as lip incompetence, and reduced facial expression. Also, the failure to treat neck contractures in children can result in inhibition of mandibular growth and disturbances of the cervical spine.
Based on the position of neck contracture, they can be either central, lateral, or complete, while depending on the percentage of the anterior neck involved, they can be classified as mild, moderate, extensive, or severe[1]. The range of motion in anterior cervical contractures is limited, especially in extension, additionally, if the scar extends to the face and neck, it could lead to a synechia effect.
Early treatment is the key to avoiding severe burn neck scar contracture, but despite the overall advances in burn management injuries, plastic surgeons still face challenges in managing severe neck contractures, as consequence of burn injuries. Skin grafting, local and free flaps, tissue expansion are some of the techniques used to treat post burn neck contractures, of them skin grafting with splinting is the preferred technique, but with a high likelihood of contracture recurrence. Flaps are commonly utilized in reconstruction techniques, such as perforator flaps, super thin flaps, and expanded flaps, each with its own advantages, and disadvantages, but the flap that relies on the vascular net of the cervical artery and its branch, the supraclavicular artery, is well-known and has been a subject of controversy for a long time. Still, for neck contractures, it is an extremely reliable local flap, as it provides a thin, pliable skin with good color match, but keeping the donor site morbidity at bare minimum. In our experience, the skin’s ability to stretch after surgery, further improves neck mobility and contour, and is an added benefit.
Since 2021, the supraclavicular flap became our go-to procedure for treating post-burn neck contractures, we employ them as pedicled or island flaps.
Previous studies examined individuals' complaints of neck contracture following a burn, surgical treatment was employed in one study, depending on the patient's grade. Patients were ranked

from 1 to 4 according to the severity of their contractures using an algorithm system, grade 1 being the most severe. Following the implementation of the algorithm-recommended surgical solutions, 83.33% patients expressed high satisfaction with the results of their post-operative procedures, whereas 16.7% patients expressed dissatisfaction, of them grade 2 patients, who underwent supraclavicular flap surgery, were the most satisfied with their treatment[1].
In a different study, patients aged 12 to 46 underwent reconstruction using supraclavicular flaps, aged 12-46 years, of them, 32% were men and 68% were women. Of these, 18% reported complications, 6% had flap haematoma, while 12% reported flap necrosis[2].
Preserving cosmetic appearance, improving the mentosternal angle, restoring full range of motion, and most importantly, preventing recurrence are the main objectives when reconstructing severe neck contractures. In order to minimize skin differences, adjacent locoregional flaps have been the gold standard for reconstructing the neck after a burn, but striking a balance between minimizing donor site morbidity and scar resurfacing is a difficult task, that relies on the size of the area and region involved as well as the availability of skin that is not scarred for flap reconstruction.
Even though there are numerous surgical treatment options for post-burn neck contractures, it is still unclear which surgical option is best, according to a systematic review. This puts surgeons in a difficult situation[9].
The present study was conducted to compare functional outcome of supraclavicular artery flap to skin grafting in management of post burn neck contractures. The purpose of this study was to scrutinize the outcome in consideration of acceptable extension/movement of neck & aesthetics.

2. Objectives:

In this article, a total of 50 flaps are studied retrospectively and their efficacy & functional outcome in reconstruction of post-burn neck scar contractures is discussed, comparing skin grafting with supraclavicular flap. Donor-site morbidity, patient satisfaction, functional improvement and complications were also evaluated.

3. Material & methods:

Study design is a retrospective in hospital study which was conducted at department of Burns & reconstructive surgery, Liaquat university of medical & health sciences, Jamshoro/ Liaquat university hospital Hyderabad, Sindh. It was done over a period of 02 years, from July 2021 to June 2023 after approval from ethical review board. A total of 50 patients were included in study, patients were than divided into 2 groups A & B, with 25 patients undergoing skin grafting, while the rest undergoing reconstruction with supraclavicular artery flap. Of them in only 06 patients islanded supraclavicular flap was done, while in rest of 19 patients pedicled supraclavicular flap was done. In hospital stay was limited to 02 days after surgery, after discharge first follow-up visit was on 05th postoperative day, then on 10th postoperative day. The patients were advised to wear soft cervical collar for 03 months postoperatively from 1st postoperative day. The patients were subsequently followed at 03 months, 06 months & 01 year postoperatively to evaluate the range of neck motion & postoperative improvement in neck extension with documentation of patient satisfaction based on Stanford-Resurge burn scar contracture scale[3]. The flap dimensions were taken, and the patients were photographed both at the time of discharge and on follow-up visits. The sampling technique used was non-probability consecutive sampling.
All genders between ages 10-70 years with any degree of post burn neck contracture, fulfilling the inclusion criteria were included in the study. Patients with burns less than 06 months old, having ASA grade III & IV, cervical spondylitis, post infectious and post inflammatory contractures were excluded from study.

Informed consent was taken from patients or their guardians. Adequate history taking, a comprehensive clinical examination that evaluated skin texture, color matching, and contouring, and pertinent radiological evaluation were all used to evaluate the patients. The cause of the burn injury and the functional grade of the neck contracture were recorded prior to the implementation of the interventional procedure. To measure objectives, the principal investigator recorded all data on a pre-made proforma and then statistically analyzed it. Confounder and bias were rigorously managed in accordance with inclusion and exclusion criteria. Post-operative appearance, functional outcome, range of motion, patient satisfaction, and complications were all calculated in terms of frequency and percentage.
In cases of patients with severe post burn neck contracture, release was first done under local anaesthesia, and patient was then subjected to general anaesthesia & SG or SCA flap was done.

Skin Grafting:
The lead researcher (S.M.) harvested and applied each graft. Compared to split thickness graft, full thickness skin grafts were preferred, for FTSG, the groin area served as primary donor site; it was either closed primarily or had STSG harvested from the thigh. The first post-graft dressing was done on the 2nd post-operative day, followed by 5th post-operative day.

SCA Flap design & elevation:
One of the principal investigators (A.S.) raised all flaps between July 2021 to June 2023. Based on the recipient's defect size requirements, the flap was harvested. Our setup uses a spindle-shaped flap on the shoulder because it facilitates primary closure of the donor site, if the flap's width is limited to 8–11 cm and its length to 20–26 cm, depending on the donor skin's laxity from the fulcrum point. Skin grafting was used to cover the donor site if primary closure was not feasible. The flap may be a skin pedicle flap or an island/vascular pedicle flap. The triangle formed medially by the posterior border of the SCM muscle, inferiorly by the clavicle, and laterally by the external jugular vein is where the supraclavicular artery originates, and branches off the transverse cervical artery. The flap's venous drainage comes from a pair of venae commitantes that connect to the external jugular vein or transverse cervical vein. The artery takeoff serves as both the beginning point for measuring the flap's length and the pivot point for rotating the flap. The flap's dimensions are limited to those listed above, but extra length could be taken to help prevent dog ear deformity upon the donor site closure. It is marked so that the anterior edge of the flap reaches the clavicle's inferior border, the posterior edge reaches the trapezius' upper border, and the distal edge reaches the upper arm. The upper arm's deltoid muscle fascia, skin, and subcutaneous tissue were all harvested in the flap. The distal end of the flap is raised first, using tenotomy scissors in the subfascial plane off the deltoid muscle after the incision is made with size 15 blade, posteriorly, the flap is raised up to the anterior border of trapezius muscle, anteriorly it is raised up to the clavicle. The dissection becomes meticulous once the acromion is reached, and the supraclavicular artery is identified here (*fig 2b*). In the majority of pedicled flap cases, skeletonization of the vascular pedicle is not required; however, if an island flap is utilized, the vascular pedicle is mobilized up to the thyrocervical trunk to enable flap harvesting with a longer pedicle. In the case of an island flap, the flap is de-epithelialized with a scalpel and rotated into the defect, the proximal skin paddle incision may be continuous with the neck dissection incision, or the flap may be tunneled into the defect. Compared to pedicled flaps, island flaps cover a far larger area and can be rotated 180 degrees (*fig 1c*). Depending on the size of harvested flap, donor site may be closed primarily, but with extensive undermining of surrounding skin envelope, or split-thickness skin graft may be harvested from thigh. To fully release the fibrous contracture bands, the recipient scars were released up to the deep fascia, prior to rotating the flap into the defect.

Fig 1. 32 year old lady with dry flame burn & grade E3 contracture.

Fig 2a. (left) Intraoperative, showing release of neck contracture. Fig 2b. (middle) showing SCA flap after being raised, arrow showing SCA artery. Fig 2c. (right) shows harvesting of islanded SCA flap.


Fig 3a. (left) 3rd postoperative day, No tip necrosis & significant increase in range of motion. Fig 3b. (middle) 7th postop day, STSG applied to donor site (left supraclavicular area). Fig 3c. (right) 3 month postoperatively, showing healthy outcome, with significantly inc range of neck motion, along with right eye ectropion correction.

4. Results:

Statistical analysis of data showed, that 48% of people with post burn contracture were very satisfied with their appearance as well as functional outcome when treated with SCA flap, while in SG group only 04% showed high satisfaction with appearance, while none showed complete satisfaction with functional outcome.

In SCA flap, 68% patients showed healthy outcome, with only 20% with flap tip necrosis and 12% with delayed partial loss of flap, which too were later treated successfully.

In patients treated with SG, approximately 20% presented with recurrence of neck contracture, while 28% presented with partial graft loss and 12% with complete loss of graft. In them only 40% showed healthy outcome, that too with functional limitations in neck extension.

Table 1: Frequency distribution of Gender, Type of burn injury, Contracture grade & intervention used:

		Frequency	Percentage
Gender	*Male*	18	36%
	Female	32	64%

Cause of Burn imjury	*Dry flame burn*	43	86%
	Acid burn	-	-
	Scald burn	03	06%
	Electric burn	04	08%
Grade of Contracture	*E1*	18	36%
	E2	18	36%
	E3	14	28%
Interventional procedure	**SCA**	**25**	**50%**
	Island flap	*06*	*12%*
	Pedicled flap	*19*	*38%*
	Skin graft	**25**	**50%**

Table 2: Distribution of gender according to groups in terms of burn grading:

Grade		Frequency	Percentage (%)
E1 (95-110°)	**SCA**	10	40%
	SG	08	32%
E2 (85-95°)	**SCA**	11	44%
	SG	07	28%
E3 (<85°)	**SCA**	04	16%
	SG	10	40%

Table 3: Comparison of patient satisfaction in both groups:

	Appearance	
	SCA	**Skin Graft**

	M	F	%	M	F	%
Not satisfied	-	-	-	3	6	36%
Somewhat dissatisfied	1	1	08%	1	2	12%
Neither satisfied nor dissatisfied	-	2	08%	1	2	12%
Somewhat satisfied	4	5	36%	2	7	36%
Very satisfied	5	7	48%	1	-	04%
	Functional outcome					
Not satisfied	-	-	-	-	8	32%
Somewhat dissatisfied	-	-	-	3	-	12%
Neither satisfied nor dissatisfied	-	3	12%	1	4	20%
Somewhat satisfied	5	5	40%	4	5	36%
Very satisfied	5	7	48%	-	-	-

Table 4: Comparison of improvement in range of motion & degree of neck extension in both groups:

Range of motion	SCA			Skin Graft		
	M	F	%	M	F	%
Significantly more range of motion	6	11	64%	-	-	-
Slightly more range of motion	4	4	32%	4	9	52%
Same range of motion	-	-	-	4	6	40%
Slightly less range of motion	-	-	-	-	-	-
Significantly less range of motion	-	-	-	-	-	-
Degree of Neck Extension						
>110°	4	9	52%	-	1	04%
95-110°	6	5	44%	4	6	40%
85-95°	-	1	04%	4	5	36%
<85°	-	-	-	-	3	12%

Table 5: Comparison of complications among both groups:

Variable	SCA		Skin Graft	
Skin graft loss	-	-	03	12%
Delayed partial loss	03	12%	07	28%
Flap tip necrosis	05	20%	-	-
Healthy outcome	17	68%	10	40%
Recurrence	0	00%	05	20%
Total	**25**	**--**	**25**	**--**

5. Discussion:

Both function as well as appearance are severely impacted by neck contractures, which are characterized by decrease in cervical range of motion. Lip ectropion, micrognathia, mandibular retrusion are some of its long-term side effects. The "visible hypothesis" postulates, that burn survivors who have scars in visible areas like face and neck may experience body image dissatisfaction because of social alienation[4]. Reconstruction of this area is difficult due to its unique configuration and the resulting neck contractures. Restoring a pleasant, tension-free facial appearance with suitable movement and expression, as well as restoring the cervicomental angle,

should be the main objectives of facial burn reconstruction. The angle created by the intersection of two lines—one from the gnathion to the hyoid bone and the other from the hyoid bone to the sternal notch—is a crucial component in the reconstruction of neck contractures[4]. The SCA flap, a local fasciocutaneous flap, taken from the skin of the shoulder and supraclavicular region, is becoming more and more popular for reconstructing post-burn neck contractures, but in situations where this option is unavailable or restricted because of donor site scarring, SG is still a better choice.

In present study, 40% of the patients were between 0-25years of age group with female predominance, 52% were between 26-50 years, again with female predominance, while only 08% were above 50 years, but with male predominance. Poor fire management techniques and a high prevalence of domestic violence are the main causes of women's predominance in developing nations. The current study data suggests that the prevalence of post-burn neck contractures in women was similar to that reported in other studies, ranging from 64% to 77.3%[5,6].

The flap measurements used in this study were comparable to or almost identical to those used in earlier research[7,8]. Additionally, the current study found no recurrences with SCA flap, while 05 with skin grafting, indicating that SCA flaps are a far better method for treating neck contractures, compared to skin grafting.

6. Conclusion:

The neck's thin, pliable skin is a site of multidirectional activity; post-burn scar contractures frequently form there, resulting in both social stigmata and functional deficit. According to the aforementioned study, supraclavicular flaps outperform skin grafting in this region, in addition, it is simple to harvest and yields good functional and aesthetic results, which increases patient satisfaction when compared to skin grafting. Furthermore, if used appropriately, it also offers a substitute for laborious and complex free-tissue transfer.

Abbreviations:

SCA: supraclavicular artery.
SG: skin grafting
SCM: sternocleidomastoid
STSG: split-thickness skin graft
FTSG: full-thickness skin graft
A.S: Dr. Aamna Sanober
S.M: Dr. Sidra memon

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