

Functional and Aesthetic Outcome of Reconstructive Surgery for Contracted Neck Scars

MOHAMED S. ABULFTOOH, M.Sc.; MOHAMMED A. FADEY, M.D.; MOHAMED R. MANSOUR, M.D.; MOHAMED H. ABDELHALIM, M.D. and MOHAMED T. YOUNIS, M.D.

The Department of General Surgery, Faculty of Medicine; Benha University

ABSTRACT

Background: Contracted scars of the neck involving the anterior cervical zone constitute a unique group of challenges compared with post-burn complications in other parts of the body. Many techniques have been advocated for reconstructing neck contractures.

Purpose: To determine and recommend the ideal skin cover for neck contracture release defects with regard to both functional and cosmetic outcomes.

Methods: A prospective and retrospective cohort study included 20 patients with various degrees of contracted scars of the neck. After releasing contracture band and resection of the unfavorable scarred tissue, remaining defects were surgically reconstructed using multiple Z-Plasties, STSGs, FTSGs and supraclavicular artery island flap with or without prior usage of a tissue expander.

Results: Excision and flap group have a higher significant functional outcome than excision with graft and Multiple Z-Plasty groups ($p=0.031$). Also, excision and flap have a lower non-significant Vancouver scar scale than other reconstruction methods without significant differences between groups. Excision and flap group have higher Patient Satisfaction score than Excision and graft and Multiple Z-Plasty groups without significant differences between groups.

Conclusion: Local and regional flaps especially the supraclavicular artery island flap provide a predictable reconstruction option not only with better color and texture match but also achieves a superior functional outcome.

Approval from the Research Ethics Committee in Benha Faculty of Medicine was granted and a fully informed written consents were taken from all patients regarding surgical procedure, photographing, possible complications and follow-up period.

Key Words: Post-burn contracture – Contracted neck scar – Neck contracture reconstruction – Supraclavicular flap – Tissue expansion.

Disclosure: All authors declare that they have no conflict of interest and haven't received any sort of financial support.

INTRODUCTION

Contracted scars of the neck involving the anterior cervical zone constitute a unique group

of challenges compared with the rest of body parts [1].

Post-burn contractures induced morbidity remains high and in fact their incidence has increased as more severely burned victims are surviving. Contracted Neck Scars affect not only the movements of the cervical joints, but also can lead to tracheal alterations and possible cervical spine distortion [2].

Numerous techniques have been advocated to reconstruct contracted scars of the neck, including multiple Z-Plasty flaps, STSGs, FTSGs, local or pedicled-flaps with or without prior usage of an appropriate tissue expander. Although different reconstructive techniques are used, limited and unsatisfactory results are usually obtained [3]. That's why, meticulous surgical planning and appropriate tissue selection for coverage is mandatory for optimal results [4].

Usually release of the limiting contracture and coverage of the resultant defect by skin grafts, local flaps or tissue expansion are adequate [5].

The purpose of any selected surgical treatment is resection of the contracted scar tissue, restoring normal movements and appearance of the neck and avoiding re-contracture. After achieving adequate release, the resulting raw area should be treated with durable coverage. Reconstructive options range from usage of split thickness skin grafts, local recruitment of surrounding healthy tissues by Multiple Z-plasties, fasciocutaneous flaps [6].

In severe cases, when there is extensive scar tissue and usage of casual methods of reconstruction can't improve the condition, free tissue transfer should be considered [5].

Donor site for such free flaps should be chosen wisely. Some authors consider harvesting required flaps from scapular and Para-scapular region for many reasons [7].

In general, local and free flaps may provide a well-vascularized cover to resurface large defects [8].

Having good color and texture match, local flaps have the advantage of being elastic and pliable. That's why they are still the best choice for contracted neck scars reconstruction [9].

In this study, we aimed to evaluate different surgical techniques used for reconstructing contracted neck scars attempting to determine and recommend the ideal skin cover for neck contracture release defects with regard to both functional and cosmetic outcomes.

PATIENTS AND METHODS

A prospective and retrospective cohort study was conducted with a sample size of 20 patients admitted in our institution with proven cases of post-burn contracted neck scars from October 2019 to June 2021 at Plastic Surgery Unit, General Surgery Department, Faculty of Medicine, Benha University.

This study was conducted after approval from the Research Ethics Committee in Benha Faculty of Medicine. Fully informed written consent was taken from all patients regarding surgical procedure, photographing, possible complications and follow-up period.

Patients aged between 5 and 50 years old. Extremities of age and patients who were unfit for surgery were excluded.

Sample size was collected based on average number of admitted patients for surgery per month. The proportion of patients operated with contracted neck scar is very low due to proper post-burn preventive precautions being applied now and poor compliance of patients with suggested surgical plans. Further studies are planned to be conducted.

The degree of neck contracture deformity was clinically evaluated and a classification system was used according to the severity of deformity and the degree of functional disability.

This included three degrees [10]:

- *Mild:* The patient is unable to extend his neck above 95° up to 110° with Obliteration of the cervico-mental angle. However, the contracture

band is manifested only during over extension of the neck.

- *Moderate:* The patient can't extend his neck above 85° to 95°. The contracture bands are manifest in the resting position, which hinder further extension of the neck.
- *Severe:* Constantly Flexed Neck and the neck contracture are preventing any neck movement and the neck extension is below 85°.

Operative technique aimed to achieve adequate contracture release and excision of any abnormal scar tissue. Resultant skin defects were reconstructed using Z-Plasty, STSGs, FTSGs and supraclavicular artery perforator flaps with or without prior tissue expansion followed by mandatory splinting and physiotherapy. Usually, a vertically-oriented contracture band could be surgically-released with multiple Z-Plasty flaps while neck contractures with intervening healthy skin could be reconstructed either with skin grafts or manipulation of local flaps after complete excision of scarred tissue. Advanced cases required a superior reconstructive option.

Post-operative follow-up:

Using neck collar, post-operative splinting [11] was required for at least 6 months to avoid recurrence of contracture. Patient Follow-up was done at 1 month, 3 months and 6 months after surgery to evaluate the long-term results, the complications and incidence of recurrence between different techniques.

Functional outcome:

Neck extension deficit was used for evaluating severity of contracture-induced functional impairment [12].

The grades include:

- N-Normal with extension greater than 110 degrees.
- E1-Extension beyond the horizontal plane parallel to the ground 95-110 degrees.
- E2-Extension and field of vision are limited to the horizontal plane between 85° and 95°.
- E3-Mento-sternal adhesions, Patient's visual field is limited below the horizontal Plane (less than 85°).

Functional outcome was evaluated with regard to range of post-operative neck extension-good if the angle is 120° or more, fair if the angle is in between 90° and 120°, and poor if the angle is less than 90°.

Vancouver Scar Scale (VSS):

Vascularity, pigmentation, pliability, height, and length were scored to assess the improvement in the scar.

Patient satisfaction:

With regard to functional & aesthetic outcome, satisfaction of the patients and their families was evaluated and scaled as follows:

Table (1): Method of assessment of patient satisfaction.

Poor	No change	Moderate	Good	Very Good
-1	0	1	2	3

Statistical analysis:

The collected data was tabulated using Statistical package for Social Science (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.). Data were presented and suitable analysis was done according to the type of data obtained for each parameter. The Mean and standard deviation (mean ± SD) were used to describe the parametric numerical data. The frequency and percentage were used to describe the non-numerical data. The groups were compared with Student *t*-test and chi-squared test. For all these tests, the level of significance (*p*-value) was adjusted to <0.05.

RESULTS

A total of 20 patients with contracted neck scar were enrolled in the study, their mean of age was 27.51±3.28 year and the majority (70%) was males.

Considering type of the scar, 3 (15%) patients had linear shape, 6 (30%) band and 11 (55%) patients had broad type (Table 2). Regarding grading of the scar, mild was 15%, moderate 70%, severe 10% and 5% was extensive (Fig. 1).

According to methods of reconstruction, Multiple Z-Plasty was done in 6 (30%) of patients, Scar excision and skin grafts (split-thickness) in 6 (30%), full-thickness in 4 (20%) and Scar excision and Supraclavicular flap coverage in 4 (20%) of patients (Table 3).

Regarding post-operative complications, Poor color match was 20%, recurrence of contracture 10%, graft loss >10% was 10%, >25% was 5% while no graft loss >50%, flap congestion 5% and hypertrophic scar 5% (Table 4).

Excision and flap group have a higher significant functional outcome than excision with graft

and Multiple Z-Plasty groups (*p*=0.031). Also, excision and flap have a lower non-significant Vancouver scar scale than other reconstruction methods without significant differences between groups (Table 5). Excision and flap group have higher Patient Satisfaction score than Excision and graft and Multiple Z-Plasty groups without significant differences between groups (Table 6).

Table (2): Distribution of patients regarding type of scar.

	Cases (n=20)	
	No	%
Linear	3	15
Band	6	30
Broad	11	55

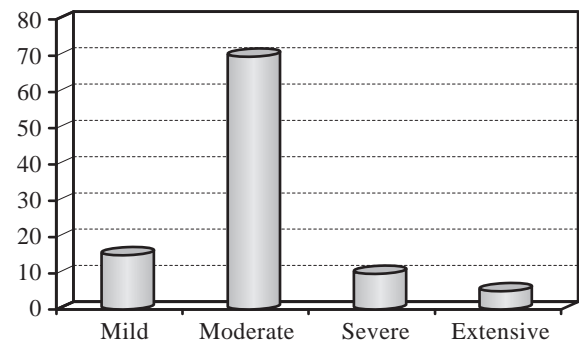


Fig. (1): Distribution of patients regarding severity of the scar.

Table (3): Distribution of patients regarding methods of reconstruction.

	Cases (n=20)	
	No	%
Multiple Z-Plasty	6	30
Scar excision and skin grafts:		
- Split thickness	6	30
- Full thickness	4	20
Scar excision and Supraclavicular flap coverage	4	20

Table (4): Distribution of patients regarding post reconstruction complications.

	Cases (n=20)	
	No	%
Poor color match	4	20
Recurrence of contracture	2	10
Graft loss:		
>10%	2	10
>25%	1	5
>50%	0	0
Flap complication:		
Flap loss	0	0
Flap congestion	1	5
Hypertrophic Scar	1	5
Total	11	55

Table (5): Distribution of patients regarding reconstruction outcome.

	Excision and graft (n=10)	Excision and flap (n=4)	Multiple Z-Plasty (n=6)	<i>p</i> -value
<i>Functional outcome:</i>				
N	5 (50%)	3 (75%)	3 (50%)	0.031*
E1	4 (40%)	1 (25%)	2 (33.3%)	
E2	1 (10%)	0 (0%)	1 (16.7%)	
E3	0 (0%)	0 (0%)	0 (0%)	
<i>Vancouver scar scale:</i>				
Mean ± SD	2.36±0.91	2.24±0.53	2.47±0.71	0.283
Range	(1-4)	(1-4)	(1-4)	

Chi square test. ANOVA test. **p*-value is significant.

Table (6): Distribution of patients regarding patient satisfaction.

	Excision and graft (n=10)	Excision and flap (n=4)	Multiple Z-Plasty (n=6)	<i>p</i> -value
Poor	2 (20%)	0 (0%)	1 (16.7%)	0.163
No change	4 (40%)	0 (0%)	2 (33.2%)	
Moderate	3 (30%)	1 (25%)	1 (16.7%)	
Good	1 (10%)	2 (50%)	1 (16.7%)	
Very good	0 (0%)	1 (25%)	1 (16.7%)	



Fig. (2): (A) Antero-Posterior view of a 16 years old patient with Broad Neck Contracture. (B) To increase the desired flap area, a tissue expander was implanted in the supraclavicular region then inflated gradually. (C) Post-operative Photo showing increased range of neck extension and good color match after usage of the pre-expanded supraclavicular flap.

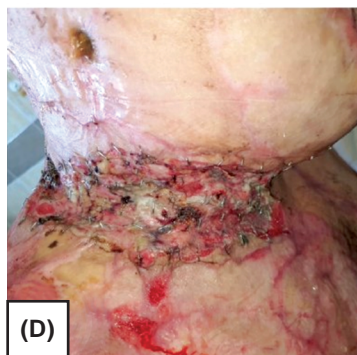
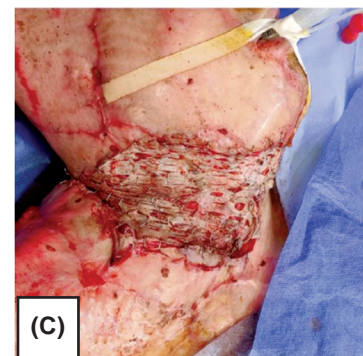
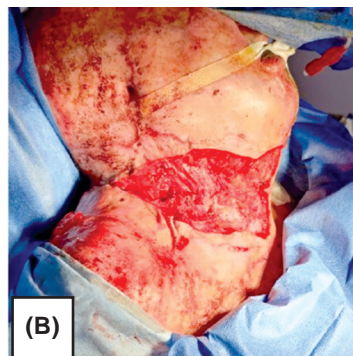
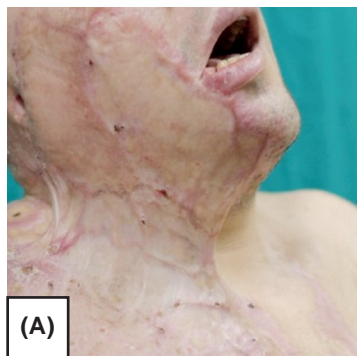


Fig. (3): (A) Pre-Operative Photos of 34 Years Old Male presenting with Post Chemical-Burn neck Contracture. (B) Intra-Operative Photo after adequate release of contracture incising all scarred tissue reaching a healthy tissue plane. (C) After application of the harvested skin graft over the raw area. (D) Early Post-operative lateral view showing modest graft intake with some degree of early graft contracture.

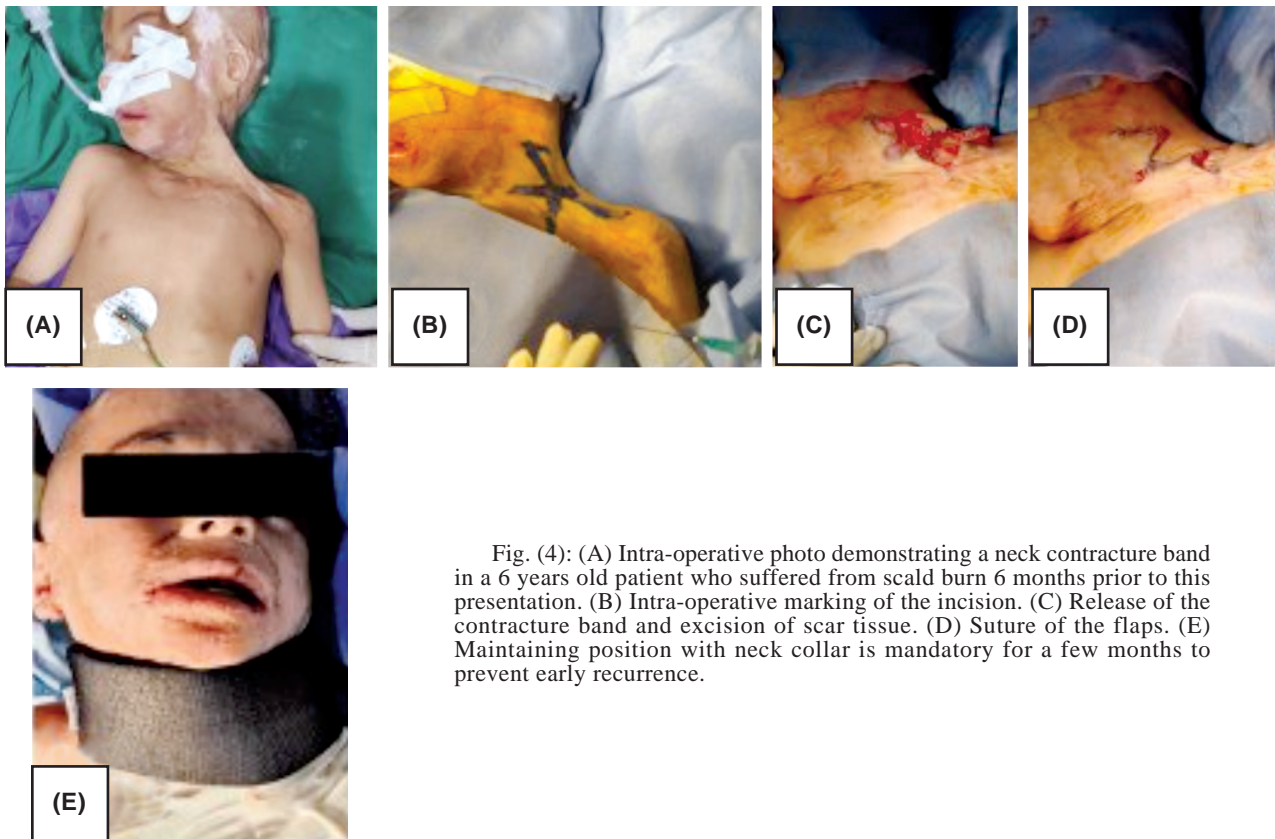


Fig. (4): (A) Intra-operative photo demonstrating a neck contracture band in a 6 years old patient who suffered from scald burn 6 months prior to this presentation. (B) Intra-operative marking of the incision. (C) Release of the contracture band and excision of scar tissue. (D) Suture of the flaps. (E) Maintaining position with neck collar is mandatory for a few months to prevent early recurrence.

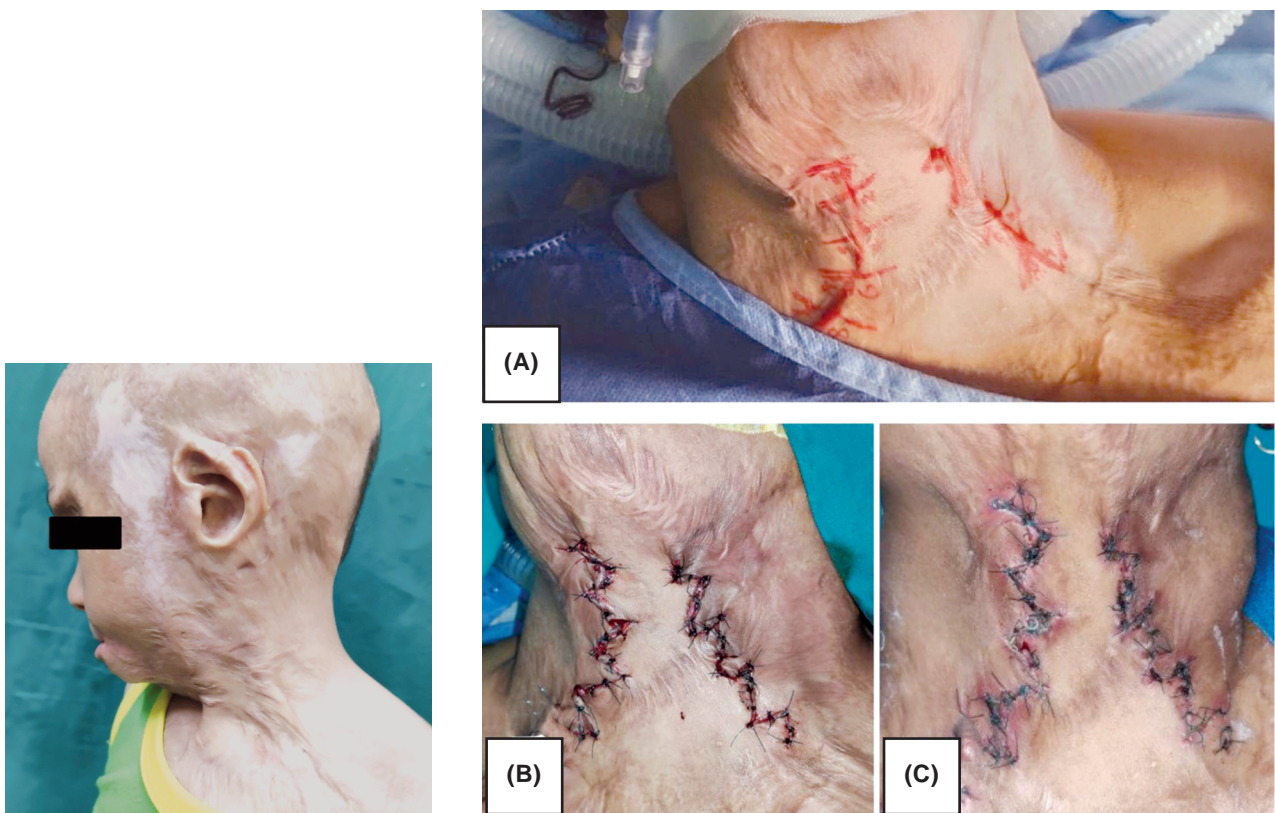


Fig. (5): Late post-operative lateral view.

Fig. (6): (A) Intra-operative photo showing the identified contracture bands limiting range of neck extension. (B) Intra-operative photo after release of the identified contracture bands using z-plasty technique. (C) Early Post-operative Photo showing improved range of neck extension after contracture release using multiple Z-Plasty technique.

DISCUSSION

Contractures of the neck constitute a devastating functional and aesthetic problem for patients and a difficult challenge for the surgeon [13].

Severely contracted scars are commonly seen in the developing countries, a result of the wide spread of unsafe fire utilities and inadequate burn care. When deeply burnt tissues are allowed to heal conservatively, patients often develop neck contracture [14].

Different modalities for reconstruction have been suggested for neck contractures surgical treatment [15]. When a small limited contracture band develops, Z-plasty incisions and local flaps can be a good surgical choice. Full thickness skin grafts have multiple benefits, being relatively available and provide acceptable neck contour without significant morbidity of donor site [16]. They (FTSGs) may provide durable coverage for post-burn contracture release defects or stand as a backup plan to cover improperly-healed areas of an already reconstructed contracted neck scar [7].

One of the Main arguments against skin grafts as a surgical solution in such cases is the inevitable post-operative graft contraction that impairs the functional outcome with regard to neck range of movement. However, novel techniques of reducing FTSGs contraction using dermal substitutes are promising [17]. On the other hand, when a wide area is involved in contracture, it is difficult to reconstruct the neck using conventional methods because skin grafting often results in postoperative re-contracture, and the amount of uninvolved skin available for use as a local flap is usually insufficient [18].

As regard Distribution of patients regarding type of scars our results showed that Linear scars 3 cases (15%), Band scars 6 cases (30%), Broad scars 11 cases (55%). In the study of Makboul & El-Oteify [10], they found as regard Distribution of patients regarding type of scars that Linear scars 97 cases (69.2%), Band scars 35 cases (25.1%) and Broad scars 8 cases (5.7%).

As regard distribution of patients regarding severity of the scar our results showed that Mild 3 cases (15%), moderate 14 cases (70%), Severe 2 cases (10%) and Extensive one case (5%).

Regarding distribution of patients according to severity, Mild was 79 cases (56.4%), moderate 47 cases (33.6%), and Severe 14 cases (10%) [10].

As regard distribution of patients regarding methods of reconstruction our results showed that Multiple Z-Plasty 6 cases (30%), Scar excision and skin grafts Split thickness 6 (30%) Full thickness 4 cases (20%) and scar excision with Supraclavicular flap coverage 4 cases (20%).

In the study of Makboul & El-Oteify [10] in linear scar contracture type, local flaps were used for mild degrees of contractures using Z-plasty flaps (22 cases), multiple Z-plasty (45 cases) and moderate degrees were also reconstructed using Z-plasty (5 cases), multiple Z-plasty (8 cases) or double-opposing Z-Plasty (12 cases). All contractures were adequately released and the scar tissue was excised until healthy underlying tissues were visualized.

As regard distribution of patients regarding post reconstruction complications we found that; Poor color match 4 cases (20%) Recurrence of contracture 2 cases (10%), Graft loss: >10% 2 cases (10%), Graft Loss >25% one case (5%), Graft Loss >50% 0 cases (0%), Flap complication: Flap loss 0 cases (0%), Flap congestion 1 cases (5%), and Hypertrophic Scar 1 case (5%).

In study of Mody et al., [2] they found that as regard distribution of patients regarding post reconstruction complications: Poor colour match (27%) Recurrence of contracture (13%) and Hypertrophic scar (13%).

Also, as regard distribution of patients regarding post reconstruction complications Makboul & El-Oteify [10] found that Partial flap dehiscence was noted in only 4.5% of patients (5 cases), treated conservatively with dressing and did not require further surgical interventions.

As regard distribution of patients regarding reconstruction outcome our results showed that Excision and flap group have a higher significant functional outcome than excision with graft and Multiple Z-Plasty groups ($p=0.031$). Also, excision and flap have a lower non-significant Vancouver scar scale than other reconstruction methods without significant differences between groups.

Our results were supported by the study of Mody et al., [2] as they found that Local flaps have many advantages that make them ideal solution to be used when adequate. Skin Grafts if used are preferable to be placed in flap donor site or at least in non-visible area of the neck. When both a flap & a skin graft are simultaneously used, it's better for the flap to be placed in a horizontal intersecting manner in between two skin graft patches.

Also the study of Makboul & El-Oteify [10] found that in linear neck contractures, especially in mild and moderate degrees, when local non-scarred tissue is present, local flaps such as Z-plasty flaps or double-opposing Z-plasty (5-flap) can be used to adequately release and abolish the contracture band.

As regard distribution of patients regarding Patient Satisfaction our results showed that that Excision and flap group have higher Patient Satisfaction score than Excision and graft and Multiple Z-Plasty groups without significant differences between groups.

Our results were supported by the study of Mody et al., [2] as there were fourteen patients treated within 1 year of burns for functional disability. Excisional release was performed in 13 and incisional release in 9 of our patients. Resurfacing with STSG (split thickness skin graft) was carried out in 19 cases and a local or regional flap with or without a graft in 3 patients and 86.4% of the patients had acceptable neck function and cosmetic result.

Conclusion:

It's always possible to achieve adequate Excision of all scar tissue in severe cases of neck contractures. However, incisional release is required in broad neck contractures. Skin grafting remains a simple, reliable and safe operation, but has its disadvantage of healing complications such as hypertrophic scarring and a higher incidence of re-contracture. Local and distant flaps especially the supraclavicular artery flap provide a predictable reconstruction option not only with better colour match but also achieves a superior functional outcome. Further studies are required with broader specimen number and long-term follow-up period.

REFERENCES

- Margulis A., Agam K., Icekson M., Dotan L., Yanko-Arzi R. and Neuman R.: The expanded supraclavicular flap, prefabricated with thoracoacromial vessels, for reconstruction of postburn anterior cervical contractures. *Plastic and Reconstructive Surgery*, Jun. 1; 119 (7): 2072-7, 2007.
- Mody N.B., Bankar S.S. and Patil A.: Post burn contracture neck: Clinical profile and management. *Journal of clinical and diagnostic research: JCDR*, Oct. 8 (10): NC12, 2014.
- Albarah A., Kishk T., Megahed M., Elsakka D. and Ghareeb F.: Pre-expanded extended island parascapular flap for reconstruction of post-burn neck contracture. *Annals of burns and fire disasters*, Mar. 31; 23 (1): 28, 2010.
- Hayashida Kenji and Akita Sadanori: Surgical treatment algorithms for post-burn contractures. *Burns & Trauma*, 5. 10.1186/s41038-017-0074-z, 2017.
- Karami R.A., Atallah G.M., Makkawi K.W. and Ibrahim A.E.: The use of the alt perforator flap for reconstruction of severe pediatric burn scar contractures. *Ann. Burns Fire Disasters*, Jun. 30; 33 (2): 143-148. PMID: 32913436; PMCID: PMC7452598, 2020.
- Nagaprasad, Nangineedi and B. Karthik: Management of post burn contracture of neck in a tertiary burn care centre. *International Journal of Scientific Research*, 33-35. 10.36106/ijrsr/2601210, 2021.
- Romansky Roman, Sharkov Evgeni and Komtski Stefan: Unusual pattern of partial failure of preexpanded free parascapular flap for neck reconstruction. *International journal of burns and trauma*, 8: 114-116, 2018.
- Tsai F.C., Mardini S., Chen D.J., Yang J.Y. and Hsieh M.S.: The classification and treatment algorithm for post-burn cervical contractures reconstructed with free flaps. *Burns*, Aug. 1; 32 (5): 626-33, 2006.
- Wang X.K., Zhai Q.K., Xue L., Lu L., Wang Y.X. and Wang Z.L.: Treatment of postburn anteriorly located neck contractures with local flaps. *Journal of Craniofacial Surgery*, Sep. 1; 23 (5): e387-90, 2012.
- Makboul M. and El-Oteify M.: Classification of post-burn contracture neck. *Indian journal of burns*, Jan. 1; 21 (1): 50, 2013.
- Bhatnagar A. and Singh A.: The postburn severe flexion contracture neck correction with split-thickness skin graft: Our experience. *Indian J. Burns*, 28: 36-43, 2020.
- Yang J.Y., Tsai F.C. and Chana J.S.: Use of free thin anterolateral thigh flaps combined with cervicoplasty for reconstruction of postburn anterior cervical contractures. *Plast. Reconstr. Surg.*, 110: 39-46, 2002.
- El Sakka D.M., Al Mobarak B.A. and Mohamed M.E.: Reconstruction of Post Burn Neck Contracture Using Full Thickness Skin Graft. *Modern Plastic Surgery*, Apr. 8; 8 (02): 21, 2018.
- Antia N.H.: Organization of Plastic in Developing Countries. *British Journal of Plastic Surgery*, 38: 24-29. [https://doi.org/10.1016/0007-1226\(85\)90082-7](https://doi.org/10.1016/0007-1226(85)90082-7), 1985.
- Sever C., Kulahci Y., Eren F., Sahin C. and Yuksel F.: Reconstruction of postburn cervical contractures using expanded supraclavicular artery flap. *Journal of Burn Care & Research*, Jul. 1; 34 (4): e221-7, 2013.
- Tseng W.S., Cheng M.H., Tung T.C., et al.: Microsurgical Combined Scapular/Parascapular Flap for Reconstruction of Severe Neck Contracture: Case Report and Literature Review. *The Journal of Trauma: Injury, Infection, and Critical Care*, 47: 1142, 1999.
- Meares Charles, Illie Vlad, Li Zhe and Maitz Peter: A novel technique of reducing full-thickness skin graft contraction using a dermal substitute: An animal model study. *European Journal of Plastic Surgery*, 43. 10.1007/s00238-020-01661-9, 2020.
- Chang L.S., Kim Y.H. and Kim S.W.: Reconstruction of burn scar contracture deformity of the extremities using thin thoracodorsal artery perforator free flaps. *ANZ Journal of Surgery*, 1-6, 2021.