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Comparative evaluation of three methods of skin graft fixation for split thickness skin graft after release of post burn contracture of the neck

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ABSTRACT

Objectives: Split thickness skin graft is an essential component of release of post burn contracture of neck. There are many methods of fixation of skin grafts; however, there is lack of objective comparison between different techniques. This study has been designed to compare three commonly used techniques of split thickness skin graft fixation methods. Surgical time, advantages, cost factor and post-operative outcome have been compared amongst three techniques.

Methods: A randomized interventional comparative study was conducted to compare three methods of skin graft fixation in patients of 10-50 years age group, with contracture of more than 3 month duration having more than 100 cm^2 skin defects after contracture release. Resurfacing of the defects after contracture release was carried out in all the groups using autologous split skin grafts. Patients were included in three groups; Group 1: tie over method, Group 2: skin stapler fixation and Group 3: Cyanoacrylate glue fixation.

Results: Mean duration of fixation procedure was 34 min in tie over group, in skin stapler group 7 min and in cyanoacrylate group 12 min. Mean cost of fixation material was 10.23 USD in tie-over group, 11.23 USD in stapler group and 40.06 USD in cyanoacrylate group. Mean score of pain/discomfort (visual analog score) on dressing removal in tie-over group was 3, for skin stapler group was 2.9 and that for cyanoacrylate glue group was 1.8. mean graft take was found to be 90.1% in tie-over group, 94.1% in skin stapler group & 93.8% in cyanoacrylate glue group. On logistic regression analysis, keeping all the variables constant in the groups the complications as the outcome variable, three groups are comparable. The need for regrafting remains inconclusive.

Conclusions: Skin stapler method for skin graft fixation was least time consuming, affordable and highly reliable when graft take success was considered. Cyanoacrylate glue fixation method was least painful and reliable in terms of graft take success though costlier than other two

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1. Introduction

Burn is one of the most devastating conditions encountered in medicine.The pain and distress caused by a major burn injury are not limited to the immediate event. The visible physical and the invisible psychological scars are long lasting and often lead to chronic disability [1].

Involvement of the head and neck occurs in 25–45% of patients with burn injuries [2]. Skin of the lower face and neck is particularly vulnerable to full thickness destruction by thermal burns [3]. As a result of fibrosis and spontaneous epithelisation on flexor surface a broad scar contracture of the anterior neck may result, or the contour of the neck may be completely obliterated [4].

The use of skin grafts is the gold standard for resurfacing of defect following release of post burn contracture [5]. Skin graft is harvested from unburnt donor area and is less-bulky while using over the flexor surfaces of the body.

Skin graft fixation is essential for the purpose of its stability during vascularisation, take and healing [6]. There are several methods of securing skin graft at the recipient site. The present study was carried out to compare three commonly used skin graft fixation methods i.e. tie over, skin stapler and cyanoacrylate glue, which are used in our hospital [7]. This study was planned to be useful in clinical practice as to know which method is faster, cost effective and overall suitable in our set up.

2. Material methods

2.1. Trial design

A randomized interventional comparative study was conducted after approval of institute protocol committee and the institutional ethics committee (no-160/2011).

2.2. Study population

The patients with post burn neck contracture admitted inthe Department of Burns, Plastic and Maxillofacial Surgery, Safdarjung Hospital, New Delhi during December 2011–November 2013, irrespective of sex were, included in the study. Patient of 10 years–50 years of age with more than 3 month post burn contracture, more than 10 gm% hemoglobin and more than 100 cm^2 defect after contracture release were included (Fig. 1). Patients with associated chronic diseases, diabetes mellitus, tuberculosis, bleeding diathesis etc. were excluded from the study.

2.3. Allocation

Group 1: Skin graft fixation by tie over method.

Group 2: Skin graft fixation by skin stapler.

Group 3: Skin graft fixation by Cyanoacrylate glue (2-Octyl Cyanoacrylate).

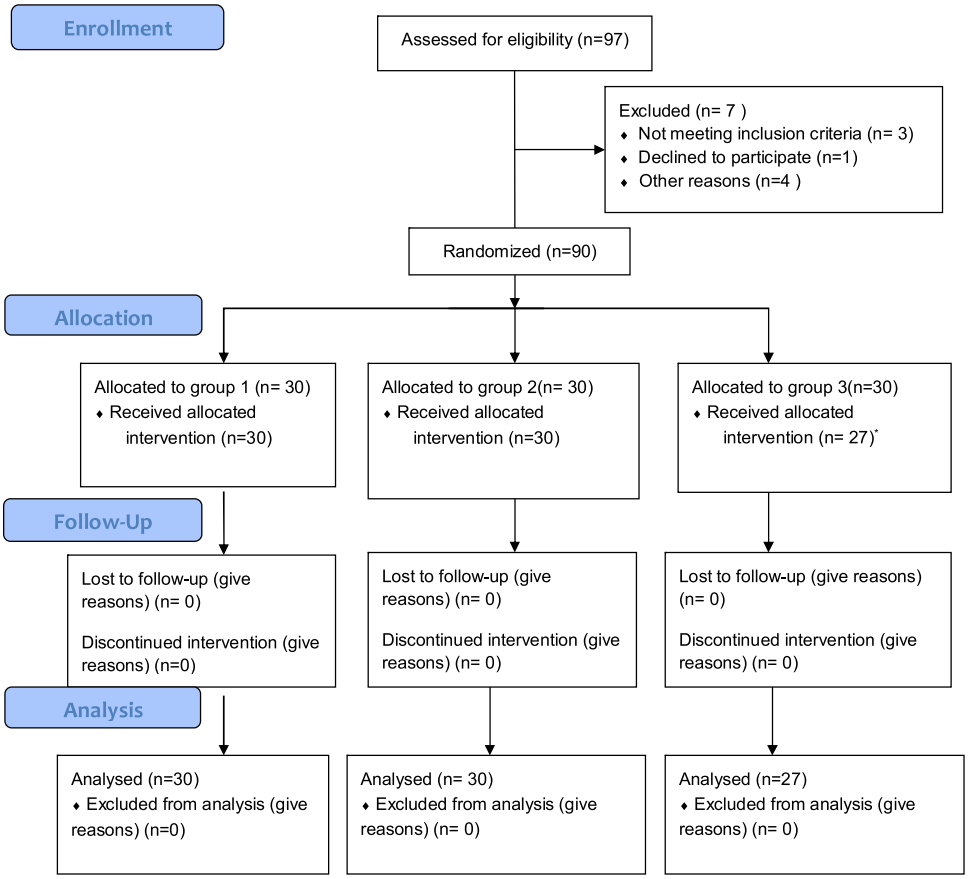

Fig. 1 – The patient flow diagram. *Indicates 3 patients were enrolled but not operated.

2.4. Sample size

Sample size was statistically calculated and 30 patients were allocated in each group. Total sample size was 90 for the study.

2.5. Randomization

The randomization of patients was done by "envelop method". Unmarked identical envelopes containing numbers 1, 2 or 3 were used with the tokens indicating the groups. The allocation was done by a person other than the investigators. Total of 90 patients were enrolled in the study with 30 patients in each group. A written patient information sheet was handed over to the patients and an informed written consent was taken from the patient and a guardian.

2.6. Intervention in each group

Post burn neck contracture was released with standard technique achieving maximum extension of neck and intra-operatively. Haemostasis was achieved by judicious use of diathermy, adrenaline soaked gauge and pressure. The defect was measured by using lint piece and then placing it on a graph paper. Defect was resurfaced using intermediate (0.3mm–0.45mm) to thick (0.45mm–0.6mm) split thickness skin graft.

2.6.1. Tie-over method

Tie over method of graft fixation was employed in the group 1 patients. Silk sutures were used for tie over purpose and were placed uniformly 3cm–4cm apart fixing the skin graft to wound edges with their threads kept long. In between the silk sutures additional fixation to the wound edge was done by nylon sutures which were cut short. A layer of non-adherent paraffin tulle was placed over the graft, over it povidone iodine soaked cotton wool was placed and secured over the skin graft with the help of the long silk sutures. Additional occlusive dressing was applied and secured with Elastoplast (Fig. 2).

2.6.2. Skin stapler fixation

In group 2 patients, fixation of the graft to wound edge was done with skin staplers. Stapler pins placed uniformly 2cm–3cm apart and no additional fixation was used. An occlusive dressing was applied with a layer of non-adherent paraffin tulle and Povidone iodine soaked cotton wool as in first group secured to the surrounding normal skin with elastoplasts (Fig. 3).

2.6.3. Cyanoacrylate glue fixation

Third group of patients underwent fixation of skin graft with cyanoacrylate glue. After release and haemostasis, the surrounding skin was dried. Glue was applied to the skin graft and normal skin junction with caution not to apply directly on wound edge. Fixation was done with glue applicator every 2cm–3cm interval uniformly. Additional caution was taken not to handle the glue with instruments, gauge or gloves. The glue was allowed to dry in 5min. No additional fixation was used. Then occlusive dressing was applied with a layer of non-adherent paraffin tulle and Povidone iodine soaked cotton wool as in the other groups and secured to the surrounding normal skin with elastoplasts (Fig. 4).

Time was recorded from the start of procedure till the end of occlusive dressing, excluding the anesthesia time. Skin graft fixation time was recorded separately.

Fixation material used for graft procedure was recorded in the proforma. The cost of the study materials at the beginning of the study was considered and used uniformly throughout the study. Nylon was used in group I for fixation costing 10.23 US$ per unit, skin stapler used in group II was costing 11.35 US$ per unit and cynoacrylate glue used in group III was costing 40.64 US$ per unit during study period.

2.7. Postoperative management

Patient's neck was kept in neck extended position with a pillow under the shoulders. Patient was kept on liquid to semisolid diet for 6 days postoperatively.

First dressing change was done according to the protocol on post-operative day 6 unless there was discharge/heavy soakage/severe pain at the operative site. The discomfort on dressing removal and any other complications were recorded in the working proforma.

Second dressing was changed between days 9–12. Fixation sutures or staples were removed on 2nd dressing. Pain and complications were recorded.

2.8. Outcomes measures

For each patient, data was recorded on a pre-formed sheeton post burn period, clinical parameters, investigations, procedures and follow-up outcome. The patients were evaluated during change of dressings. Photographs were taken & percent graft was assessed by same 3 independent observers throughout the study.

Pain assessment was done using visual analogue scale (VAS) [8]. Score was recorded twice in the post-operative period on first and second dressing change and average was calculated. VAS score was categorized as mild if score was 0–3, moderate if score was 4–6 and severe if score was 7–10.

2.9. Statistical analysis

Data from each patient were entered into a spreadsheet using Excel^{TM} (Microsoft Corp, Redmond, WA), statistical analysis were done using SPSS (statistical package for the social sciences) software version 16. Kruskal–Wallis test was used for assessing comparability of groups. Mann–Whitney test was used for inter-group analysis. The overall complications have been compared by keeping all the variables constant in groups using logistic regression analysis.

3. Results

3.1. Study epidemiology

Out of 90 patients in the study, 53 (58.9%) were females and 37 (41.1%) were males. Using Chi-square test for comparing sex variable among three techniques p-value was found to be 0.015. Age range of the patients was 10–46 years with mean age of 25.7 years. Inter-group values show, mean age in group 1,

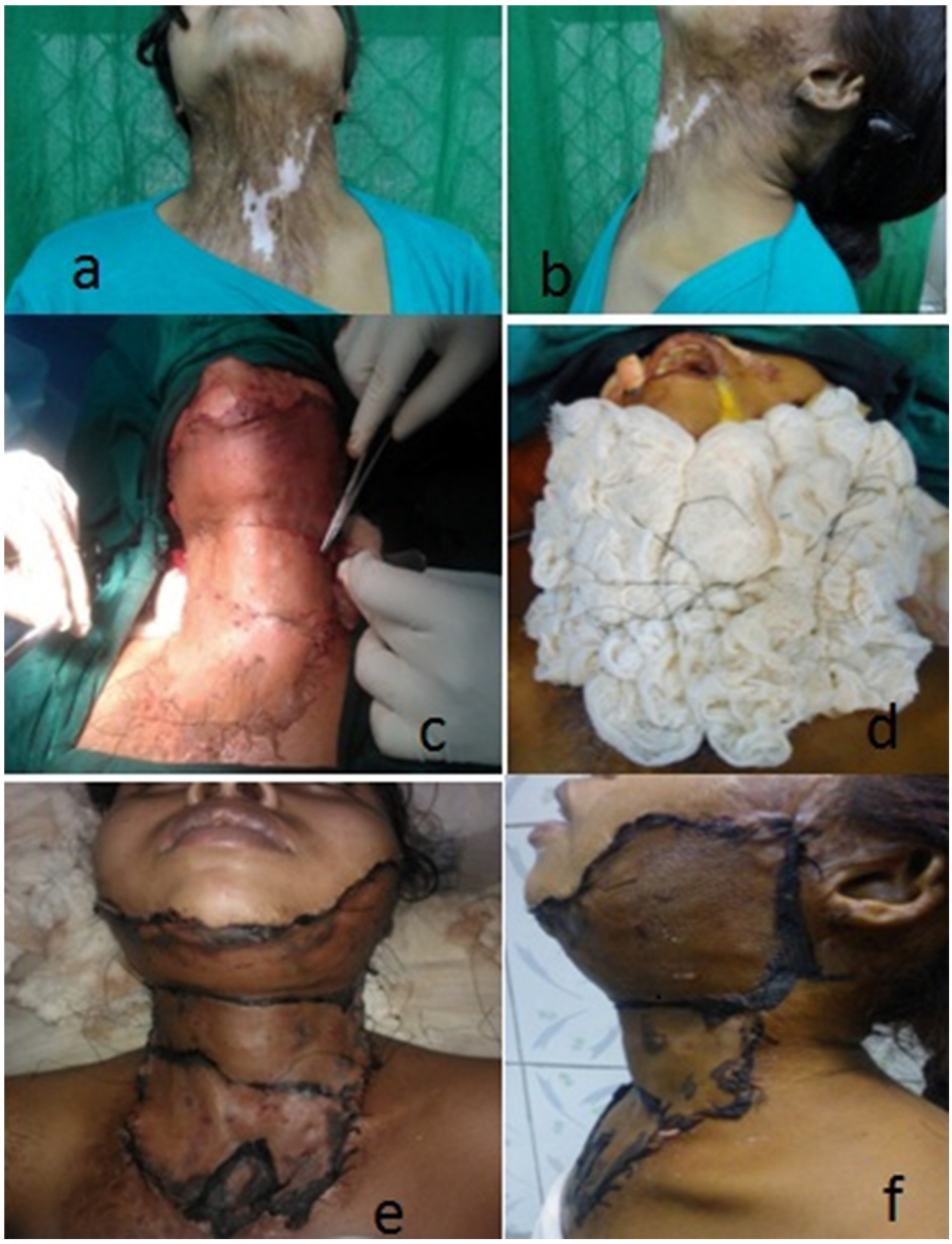

Fig. 2 – (a and b) Preoperative pictures of a patient of post burn contracture neck. (c) Intraoperative picture of release of contracture and skin grafting. (d) Split skin graft fixation with tie over dressing. (e and f) 4 month follow up photograph with well settled skin graft.

2 and 3 were 24.33, 25.9 and 26.9 years respectively. ANOVA (Analysis of variance) was used for analysis of the data p-value was found to be 0.563, which makes the groups comparable.

73 patients (81%) were affected by thermal burn and 12 patients (13.3%) sustained scald. There are 2 cases of electric burn and 3 cases of chemical burn as the etiology behind PBC neck (Table 1).

Median duration of contracture in group 1, 2 and 3 are 21, 27 and 24 months respectively. Median value for duration of contracture including all patients was 24 months. Using Kruskal-Wallis test for analysis all three groups were found to be comparable with p=0.581.

3.2. *Intraoperative observations*

Size of the raw area post contracture release was measured. Minimum defect size was 100 cm^2 and maximum defect was 426 cm^2 with mean size 195 cm^2. Group 1, 2 and 3 patients had a mean defect size 200.9 cm^2, 198.2 cm^2 and 184.8 cm^2 respectively. Kruskal–Wallis test was used for analysis, all groups were found to be comparable with p- value 0.579 (Table 2).

Operating time required for fixing the graft when tie over is used in group 1 was 34.07 min with range from 18–50 min. In group 2 mean fixation time was 7.13 min with range 2–15 min.

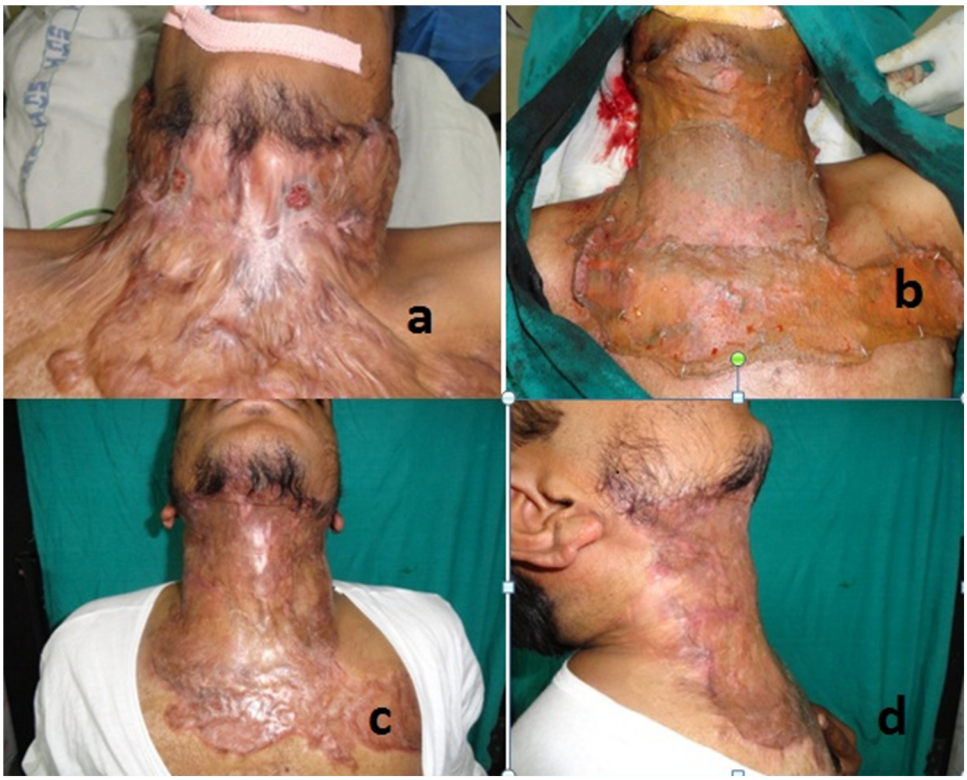

Fig. 3 – (a) Representative patient of post burn contracture neck. (b) Treated with release of contracture and skin grafting and fixed withskin stapler. (c and d) 3 month post op period showing good contour and degree of neck extension.

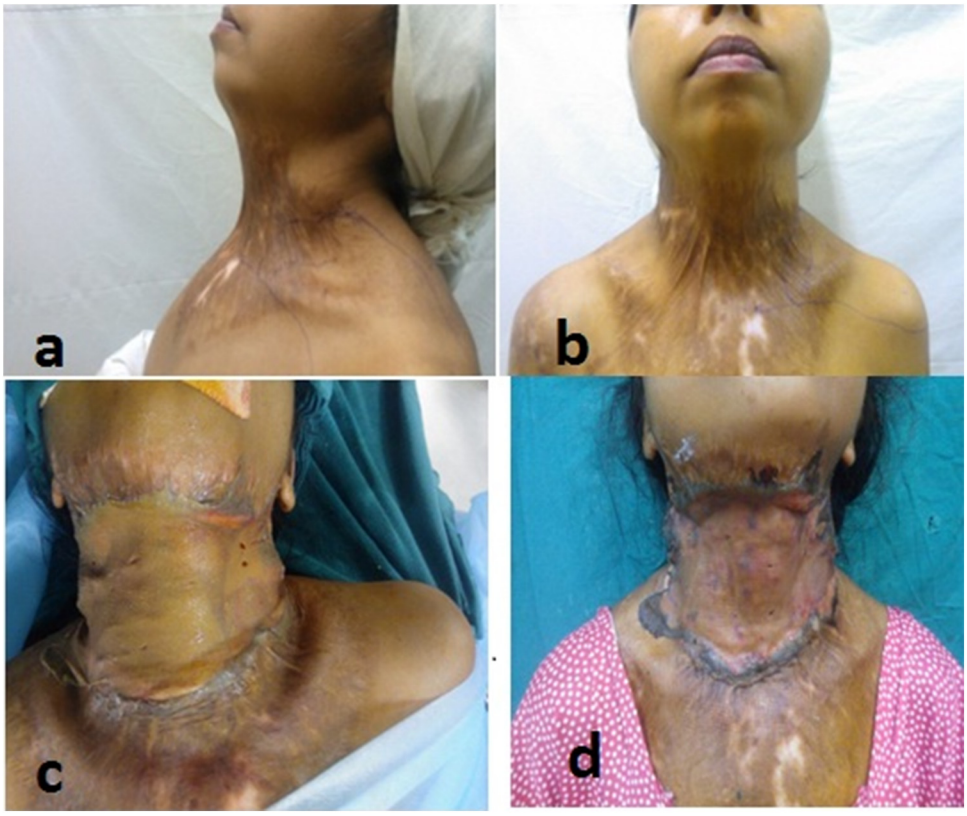

Fig. 4 – (a) Representative patient of post burn contracture side view and (b) front view. (c) Treated with release of contracture and skin grafting and fixed with cyanoacrylate glue (d) 1 week post op period.

Table 1 – Base line characteristics of the patients.

Characters	Total	Group 1	Group 2	Group 3	p-value
Number of participants	90	30	30	27	
Mean age (years)	25.71±9.28	24.33±10.70	25.90±9.80	26.90±7.07	0.563
Male	53	23	12	12	0.015
Females	37	7	18	18	0.015
Median duration of presentation (months)	24	21	27	24	0.581

Table 2 – Intra operative parameters of the patients.

Parameters	Total	Group 1	Group 2	Group 3	p-value
Mean size of raw area covered (cm^2)	195±80.842	200.97±70.892	198.23±99.208	184.78±69.799	0.579
Mean total operative time (min)	76.689±25.339	97.33±18.795	65.00±20.960	66.74±21.764	<0.001
Mean graft fixation time (min)	17.94±13.34	34.07±7.182	7.13±3.711	12.04±6.754	<0.001
Cost of material in USD$	20.06±15.52	10.23±3.15	11.35±3.46	40.64±11.61	<0.001

In group 3, mean duration was 12.04 min and range 3–25 min. Statistical analysis of the above data using Kruskal–Wallis test, there is significant difference in fixation time between three groups with lowest value for group 2 followed by group 3. Using Mann–Whitney test for inter-group analysis significant difference was observed between groups 1 & 2, groups 1 & 3 ($p<0.001$) and groups 2 & 3 ($p=0.004$). (Table 2)

Mean duration of total procedure time in group 1 (97.33 min), group 2 (65 min) and group 3 (66.74 min). Using statistical analysis there was significant difference between three groups with group 2 having lowest mean value ($p<0.001$). Using Mann–Whitney test for inter-group comparison significant difference were observed between group 1 & 2 and group 1 & 3 ($p<0.001$). While group 2 & 3 were comparable ($p=0.482$) (Table 2).

Mean cost of fixation material was 10.2 USD in ties-over group, 11.3 in stapler group and 40.6 in cyanoacrylate group. Analysis shows cost of fixation material in tie-over group was significantly less ($p<0.001$). When Mann–Whitney test was used for inter-group comparison, cost of fixation material used in tie-over group was very low in comparison to cyanoacrylate group ($p<0.001$) and when compared to skin stapler group tie-over group was found to be again cheaper ($p=0.033$). Between skin stapler and cyanoacrylate group, skin stapler group was found to be significantly cheaper ($p<0.001$) (Table 2).

3.3. *Post operative assessment*

Mean pain score in group 1 was 3, group 2 was 2.9 and group 3 was 1.8. Using Kruskal–Wallis test lowest pain scores were observed in group 3 which was statistically significant with p-value less than 0.001. When Mann–Whitney test was used for inter- group analysis groups 1 and 2 scores are comparable with $p=0.848$. Between groups 2 & 3 and groups 1 & 3, group 3 had significant lower scores ($p<0.001$) (Table 3).

For each patient, graft take was calculated by three observers, who were constant throughout the study. Mean graft take in percentage was calculated from the values obtained from the observers. Mean percentage of graft take in group 1 was 90.11%, in group 2 was 94.13% and in group 3 was 93.78%. Statistical analysis was performed using Kruskal–Wallis test and p-value was found to be 0.533 thus making three groups comparable in terms of graft take (Table 3).

Out of total 87 patients operated, Graft shearing was the commonest complication in 20 patients (23%) (Fig. 5a), hematoma and seroma together observed in 19 cases (21.8%) (Fig. 5b, c and d) and no complications were observed in 48 cases (55.2%). Among the groups, group 2 had the least complications (30%) where only hematoma/seroma was found, however, there was no case of skin graft shearing. Group 1 shows highest complications amongst the three

Table 3 – Outcomes of the three types of interventions.

	Total	Group 1	Group 2	Group 3	p-value
Mean VAS score	2.6+0.86	3+0.81	2.9+0.56	1.8+0.66	<0.001
Mean graft take (%)	92.64+9.89	90.11+14.08	94.13+7.44	93.78+5.44	0.533
Median graft take (%)	95.33	95.00	96.00	95.33	
Hematoma/Seroma no. (%)	19 (21.8%)	6 (20.0%)	9 (30%)	4 (14.8%)	0.106
Graft shearing no. (%)	20 (23%)	11(36.7%)	0 (0%)	9 (33.3%)	0.106
No complications no. (%)	48 (55.2%)	13 (43.3%)	21 (70.0%)	14 (51.9%)	
Need for re grafting in numbers (%)	6	5	1	0	

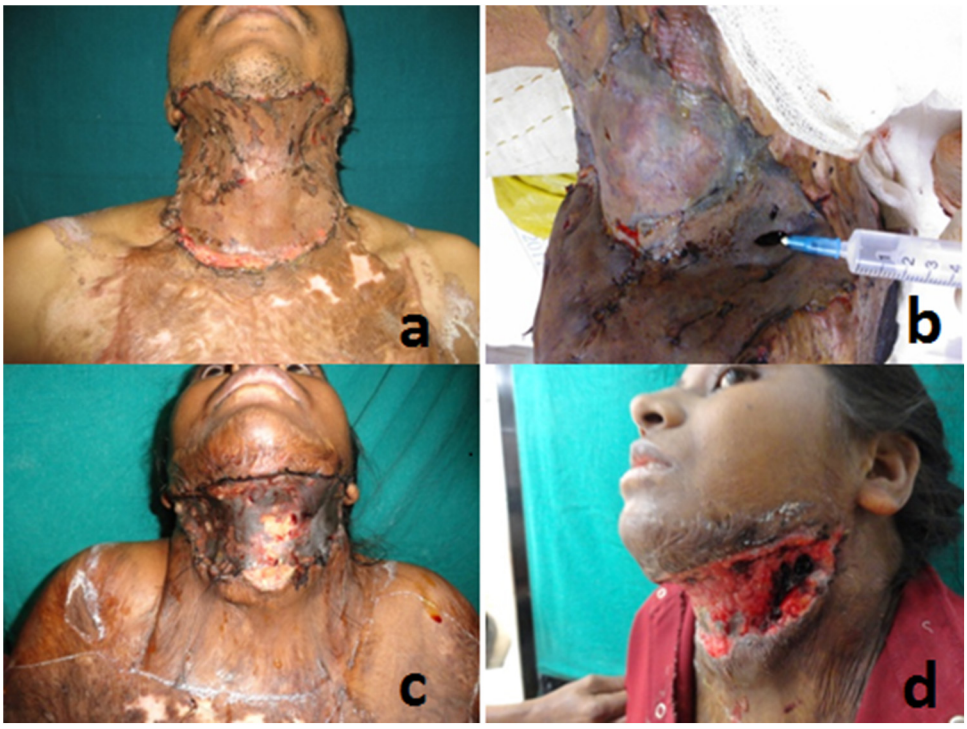

Fig. 5 – (a) Graft shearing at inferior edge. (b) Hematoma being evacuated in a patient managed in Cyanoacrylate group. (c) Presence of hematoma in a patient in tie-over group. (d) Raw area following evacuation of hematoma and dressings before regrafting.

groups though p-value using Chi-square test was found to be not significant (p=0.106). On logistic regression analysis, keeping all the variables constant in the groups the complication status as the outcome variable, three groups are comparable (Table 4).

3.4. *Need for regrafting*

5 cases in Group 1 needed supplementary split-thickness skin grafting for residual raw area, while only one case in group 2 and none in group 3 required skin grafting. Statistical analysis could not be performed due to small number of inputs (Table 3)

4. Discussion

This is a randomized comparative interventional study to compare three techniques of split skin graft fixation in post burn contracture neck patients. Three groups of the subjects were age matched and the duration of postburn period was statistically not significant.

Thermal burn and scald tops the list in etiologic factor for post burn cervical contracture with 85 patients (94.4%). Previous studies by Nath et al. showed in 33 patients (90%) cause was thermal burn & scald, in Bhattacharya et al. study all 28 patients was due to thermal burn & scald [9,10]. Higher frequency of flame burn can be attributed to congested living and floor level cooking using kerosene stoves and chullah in our part of the country [11–14].

Average duration from injury to presentation in our study was 40 months (range 6 months-25 years). The study conducted by Zhang et al. (2010) in China shows average duration of contracture in their patients as 8 years with range (1–22 years) [15]. Delayed presentation can be explained as patients in our hospital were mostly referred from distant places as tertiary care with good anaesthetic support are not available in most of the areas in a developing country like India.

4.1. *Intra-operative parameters*

Mean duration of graft fixation for cyanoacrylate glue group was 12 min which is similar to the results of Zaki et al. (mean; 12 min) in their study conducted in Queen's hospital, UK [16]. Mean

Table 4 – Multiple regression analysis comparing the complications in groups.

Groups	Beta error	Standard error	Wald test	Degree of freedom	Significance
Group 3 (glue)	−408.377	12497.432	.001	1	.974
Group 2 (stapler)	−543.106	30164.321	.000	1	.986
Group 1 (tie over)			.002	2	.999

duration of tie over fixation in our study was 34min while De Gado et al. reported 22min [17]. The difference in value can be explained as their study was conducted on different areas of body and the study did not mention about the area of grafting.

The cost of the fixation material varies significantly amongst 3 groups. This aspect has not been analysed in the literature. The cost of material used was almost same in Group 1 and 2. However, it was 4 times more expensive in the group 3 vis a vis group 1. This is an important consideration in developing countries and we need to be cost conscious. Hence the tie over dressing technique and stapler fixation are popular as compare to fixation using glue.

4.2. *Postoperative parameters*

Post-operative pain visual analog score (VAS) score recorded during first and second dressing changes was significantly different among these groups. Mean score of pain/discomfort on dressing removal in group 1, 2 and 3 were 3, 2.9 and 1.8 respectively. De Gado et al. in his study showed higher pain in tie-over patients, similarly Adler et al. found higher pain in skin stapler patients in comparison to cyanoacrylate glue fixation patients [17,18]. Meaning thereby, we have similar observation as in previous literature.

Mean graft take was comparable among three groups with 90.1% in tie-over group 1, 94.1% in group 2 & 93.8% in group 3. De Gado et al. in his study found 89.6% graft take in tie-over group irrespective of area of grafting [17]. Stone et al. had 90% grafts take with the use of cyanoacrylate glue in 107 patients [19].

Most common complication observed was shearing of graft from edges of wound and hematoma/seroma. There has no study to compare regarding complications related to different graft fixation methods. However on regression analysis the complication rate is comparable among 3 groups.

5. Conclusion

From this study we concluded that skin stapler method for skin graft fixation was least time consuming, relatively cheaper and highly reliable in terms of successful skin graft take. Cyanoacrylate glue fixation method was least painful and reliable in terms of graft take success however it is expensive. We recommend use of skin stapler for skin graft fixation following post burn cervical contracture release over traditional tie-over method.

Conflict of interest

None.

Source of funding

None.

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