

Establishing a Consensus for the Surgical Management of Chronic Burn Wounds: A Randomised Prospective Comparative Study

ASHRAF MAHER, M.D.

The Department of Plastic and Reconstructive Surgery, Faculty of Medicine, Ain Shams University.

ABSTRACT

Chronic burn wounds are those showing no evidence of re-epithelialisation within three weeks of primary therapy for the acute insult. Despite the agreement about surgery as the strategy of choice, there exist no clear consensus on the intra-operative handling of such wounds prior to skin grafting. Therefore, a randomised prospective comparative study was conducted at the Burn Unit in Ain Shams University aiming to objectively compare skin grafting with versus without down-to-fascia excision for the surgical management of chronic burn wounds. For this purpose, 72 burned patients admitted over a two-years period (December 2005-December 2007) were enrolled. Patients submitted were randomised into two groups (36 patients each) according to whether or not intra-operative down-to-fascia excision of granulating bed was performed prior to skin grafting. The mean % TBSA of grafted wounds was 6.2 ± 2.4 in Excision versus 5.6 ± 1.8 in non-Excision group (Lund and Browder Chart). Short-term evaluation included the overall graft uptake as well as graft uptake with respect to wound chronicity, qualitative wound bacteriology and serum albumin concentration. Long-term cosmetic appearance was assessed on the basis of Vancouver Scar Scale (VSS). The mean overall % graft uptake was 84.4 ± 12.2 in Excision versus 82.2 ± 12.8 in non-Excision group (statistically insignificant). Analysis of data concerning the impact of wound chronicity (21 to more than 60 days) and qualitative wound bacteriology (surface swabs) on graft uptake revealed no statistically significant difference between both study groups. Studying the impact of serum albumin concentration revealed significantly lower graft uptake with serum albumin less than 4gm% as compared to greater than 4gm% in subjects of Excision group. Fluctuation of serum albumin around 4gm% had no significant impact on graft uptake in subjects of non-Excision group. Analysis of long-term cosmetic appearance (12-weeks post-grafting) based on (VSS) revealed a significantly better outcome in subjects of non-Excision as compared to those of Excision group. Despite the comparable overall graft uptake with both protocols of handling granulating wound bed, yet down-to-fascia excision is considerably more time-consuming (haemostasis) and requires optimum pre-operative albumin concentration ($>4\text{gm}\%$), in addition to thoroughly monitored fluid/blood replacement throughout the intra- and post-operative periods. Furthermore, the procedure yielded significantly less graft cosmesis as compared to non-Excision strategy. In view of these findings, it is undoubtedly recommended to shift the balance towards direct skin grafting on non-excised granulations for the surgical closure of chronic burn wounds. It is possible that future research might enable

better understanding of the impact of handling granulating bed of chronic burn wounds on the long-term cosmetic outcome.

INTRODUCTION

Extensive burns are one of the most devastating injuries to human kind. In such injuries, the depth of thermally induced tissue destruction is often heterogenous, with areas of partial- and full-thickness dermal damage among the same burn victim. The management algorithm is primarily depth-dependent and is considered one of the most critical issues of burn care [1-3].

Since the introduction of biologic membranous materials that provide "moist environment" to the armamentarium of burn therapy, partial-thickness burns turned to be more amenable to conservative strategies than with the former era of topical antimicrobials [4-6]. With such novel dressings, it became possible to restrict surgery in the form of secondary excision to those partial-thickness areas that fail to re-epithelialise within two weeks of initial conservative therapy [7,8]. In contrast, it is widely agreed among most burn surgeons about early excision as the strategy of choice for full-thickness burn areas. Eventually, early excision has the crucial advantage of promptly eliminating eschar-derived toxins (burn/bacterial), thus aborting the toxin-mediated systemic inflammatory response (SIR) with its deleterious impact on remote vital organ function [9-11].

Over the recent years of burn practice, there have been promising developments among all aspects of therapy including novel membranous materials and skin substitutes, skin preservation and expansion measures, all aiming to achieve optimum primary and/or secondary resurfacing of extensive burns. Nevertheless, there always exist the potential of evolving chronic (residual) areas of non-reepithelialisation that eventually require

further late intervention. Chronic wounds are those showing no evidence of re-epithelialisation within 3 weeks of initial conservative and/or surgical management. They result as an outcome of originally full-thickness burn areas that were not subjected to early excision, or might alternatively evolve from deepening of partial-thickness burn areas throughout the course of management. Planning optimum therapy for chronic burn wounds gained importance from the fact that mismanagement might obviously result in prolongation of hospital stay as well as increased potential of morbidity and mortality, thus compromising the overall outcome and adding more physical and psychological trauma to critically ill burn victims [12].

Initial topical therapy for chronic burn wounds consists of sequential debridement to remove remnants of burn eschar if any, in combination with the application of agents that aim to assist in debridement, infection control and promotion of granulation tissue formation. Such primary management might be sufficient to induce re-epithelialisation of minor residual burn wounds, but major ones eventually require definitive surgical closure through skin grafting [13].

Reports in the literature concerning surgical management for chronic burn wounds, especially with regards to the impact of intra-operative handling of granulating bed on the overall outcome, are scarce and inconsistent. Therefore, this study aimed to objectively compare two surgical protocols for the management of chronic burn wounds, that is skin grafting with versus without down-to-fascia excision of granulating bed. The studied protocols were evaluated and compared with respect to their impact on both short- and long-term outcomes.

PATIENTS AND METHODS

The study included 72 burned patients admitted to the Burn Unit in Ain Shams University over a two-years period (December 2005-December 2007), with the objective to prospectively compare the short- and long-term outcomes of skin grafting with versus without down-to-fascia excision of granulating bed for the surgical management of chronic burn wounds. Subjects enrolled had ages ranging between 4 and 48 years with a mean of 21 ± 2.6 years and were 38 females versus 34 males. Burns were 44 flames versus 28 scalds and were all combining partial- and full-thickness burn areas. The % TBSA ranged between 16 and 38 with a mean of 24 ± 2.2 (Lund and Browder) [14]. The % TBSA of full-thickness burn areas ranged between

12 and 22 with a mean of 14 ± 2.5 . The % TBSA of chronic wounds (study wounds) ranged between 3 and 12 with a mean of 6 ± 1.4 . Chronic wound for the purpose of the study meant a wound that had no evidence of re-epithelialisation within 3 weeks from the day of injury.

Prior to enrollment for the study, patients were subjected to complete clinical, laboratory and bacteriological assessment. Exclusion criteria included haemoglobin concentration less than 10gm%, serum albumin less than 3.5gm%, in addition to clinical and/or laboratory evidence of burn wound sepsis. Pre-operative bacteriological assessment of study wounds consisted of qualitative surface swabs and quantitative biopsy cultures. Patients with bacterial counts greater than 105/gm of tissue in biopsy culture were withdrawn, as they were deemed unsuitable for the purpose of the study. A written consent was taken from all patients or their legal representatives before submission for the study.

Subjects were divided into two groups (36 patients each), according to the protocol of handling granulating wound bed intra-operatively. In group [A], down-to-fascia excision of granulation tissue was performed prior to skin grafting. Small areas were curetted, while large areas were excised using a hand-held skin graft knife [Downs Surgical, Sheffield, England]. Following excision, thorough haemostasis was achieved with gauze soaked in 1:200,000 nor-epinephrine for 10 minutes prior to the application of skin grafts. In group [B], granulating wound beds were on the contrast left unexcised; they were instead cleansed with povidone iodine 5%, then washed with 0.9% normal saline and directly grafted. In both groups, grafts were harvested with an electrical dermatome [Aesculap, PA, USA] using an average aperture of 0.3-0.4mm (0.012-0.016 inch.). Grafts in both groups were fixed with staples, dressed with tulle grass, then adequately padded and secured with compression garments. Splinting for further immobility was done whenever necessary. The first post-graft dressing was done on the third post-operative day, followed by every other day dressings. Final graft uptake was assessed on the 14th post-grafting day and was correlated with respect to overall uptake, as well as parameters including wound chronicity, pre-operative qualitative bacteriology and serum albumin concentration. Long-term evaluation was done 12-weeks post-grafting in the form of assessing the overall cosmetic appearance of grafted wounds. This was done using the "Vancouver Scar Scale" which has 4 major categories, namely pigmentation, vascularity, pliability and height [15].

Pigmentation is given a score of (0,1,2) for normal, hypo- and hyperpigmentation, respectively. Vascularity is given a score of (0,1,2,3) for normal, pink, red and purple, respectively. Pliability is given a score of (0,1,2,3,4,5) for normal, supple, yielding, firm banding and contracture, respectively. Height is given a score of (0,1,2,3) for normal, <2mm, 2-5mm and >5mm, respectively. Data were collected and submitted for statistical analysis.

RESULTS

Seventy-two burned subjects were included in a randomised prospective comparative study aiming to objectively evaluate the short- and long-term outcomes of skin grafting with versus without down-to-fascia excision of granulating bed for the surgical closure of chronic burn wounds. For this purpose, patients enrolled were randomly distributed on two equal study groups (A and B) according to excision or non-excision of granulating wound bed prior to skin grafting, respectively. Data analysis revealed no statistically significant difference in the mean % TBSA of grafted wounds in both groups (6.2 ± 2.4 for Excision versus 5.6 ± 1.8 for non-Excision group) (Fig. 1).

Data concerning graft uptake in both study groups are summarised in Fig. (2). The percentage of >80% graft uptake was 72.1% for Excision versus 77.7% for non-Excision group (statistically insignificant). The mean overall percent graft uptake was 84.4 ± 12.2 for Excision versus 82.2 ± 12.8 for non-Excision group. This was again statistically insignificant.

When chronicity of grafted wounds was considered, data showed no statistically significant difference between both groups with respect to greater than 80% graft uptake. Chronicity ranges

were 21-40 (n=10), 41-60 (n=8) and >60 (n=18), post-burn days, respectively (Fig. 3).

Results concerning pre-operative qualitative wound bacteriology (surface swabs) revealed prevalence of pseudomonas aeruginosa isolates in both study groups. Data analysis showed no statistically significant difference in frequency of isolation of different species in both groups (Fig. 4). There was also no statistically significant difference between both groups with respect to the incidence of greater than 80% graft uptake in relation to species of isolates. n values for gram+ve isolates were 8 in Excision versus 7 in non-Excision group. n values for gram-ve isolates were 24 in Excision versus 28 in non-Excision group (Fig. 5).

Analysis of data concerning graft uptake in relation to pre-operative serum albumin concentration revealed that in Excision group, there was statistically significant lowering in incidence of greater than 80% uptake with serum albumin lower than 4gm% as compared to that with concentration higher than 4gm%. Conversely, fluctuation of serum albumin around 4gm% had no statistically significant impact on the incidence of greater than 80% uptake in non-Excision group. n values for serum albumin <4gm% were 18 in Excision versus 20 in non-Excision group. n values for serum albumin >4gm% were 18 in Excision versus 16 in non-Excision group (Fig. 6).

Long-term assessment of cosmetic outcome was performed 12-weeks post-grafting based on the criteria set by Vancouver Scar Scale (VSS) (Fig. 7). Fig. (8) illustrates scores recorded from subjects of both groups. Data analysis revealed a mean score of 5.6 ± 1.46 for Excision versus 3.8 ± 1.22 for non-Excision group. This difference was statistically significant with a superior overall cosmetic outcome in favour of non-Excision group.

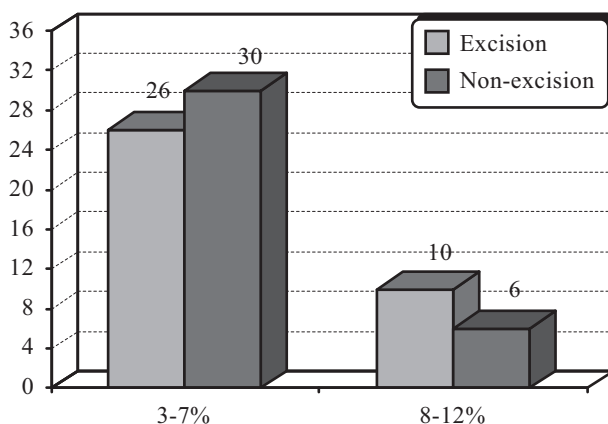


Fig. (1): The distribution of % TBSA of grafted wounds in both groups; $p > 0.05$ (statistically insignificant).

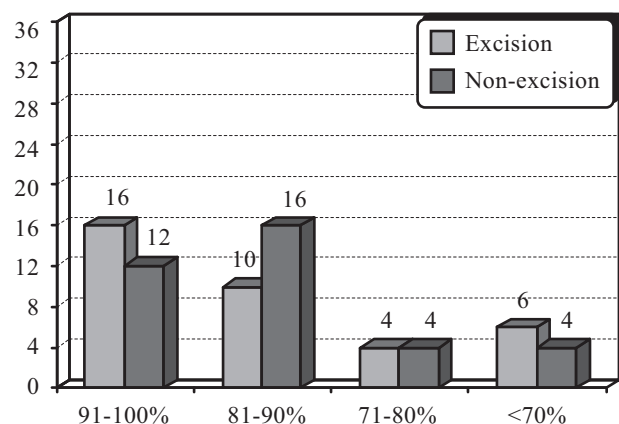


Fig. (2): The distribution of percent graft uptake in both groups; $p > 0.05$ (statistically insignificant).

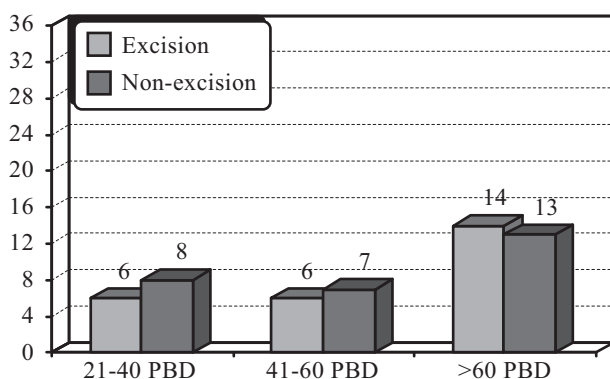


Fig. (3): The distribution of >80% graft uptake in relation to wound chronicity in both groups; $p>0.05$ (statistically insignificant).

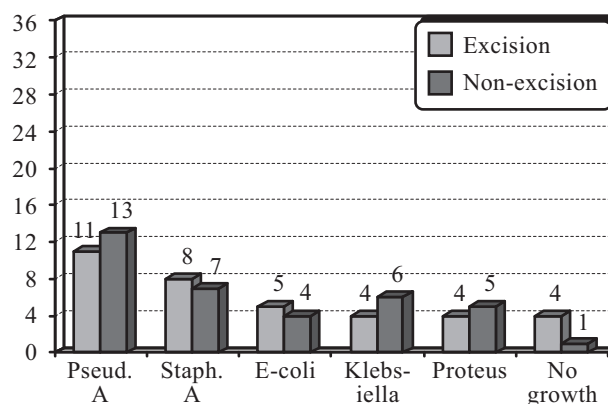


Fig. (4): The frequency of isolation of different species in both groups; $p>0.05$ (statistically insignificant).

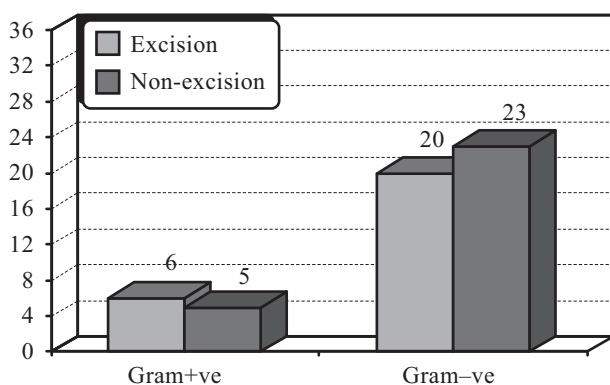


Fig. (5): Incidence of >80% graft uptake in both groups in relation to species of isolates; $p>0.05$ (statistically insignificant).

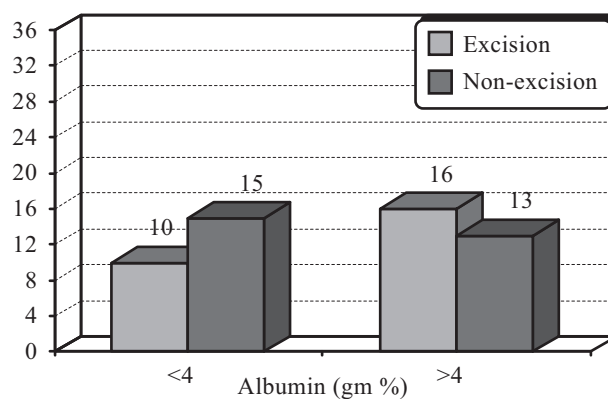


Fig. (6): Incidence of >80% graft uptake in both groups in relation to fluctuation of serum albumin around 4gm%. $p<0.05$ (statistically significant) with albumin <4gm%. $p>0.05$ (statistically insignificant) with albumin >4gm%.

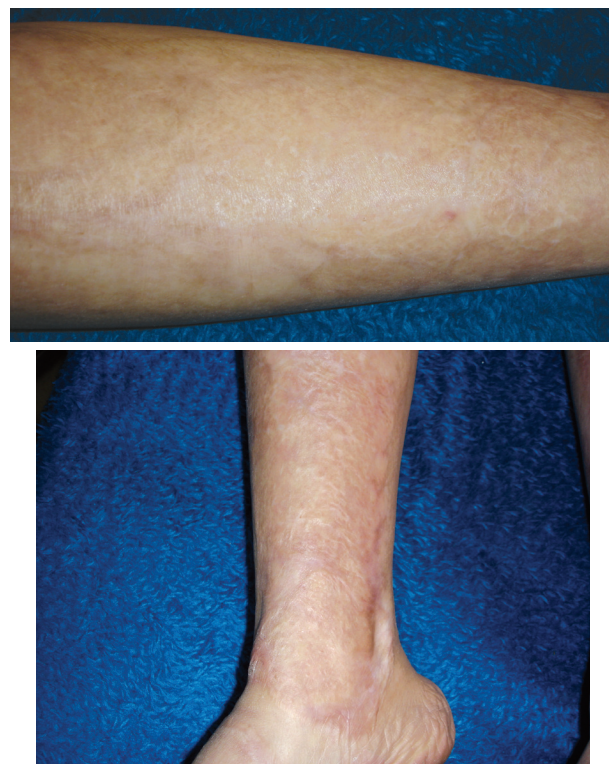
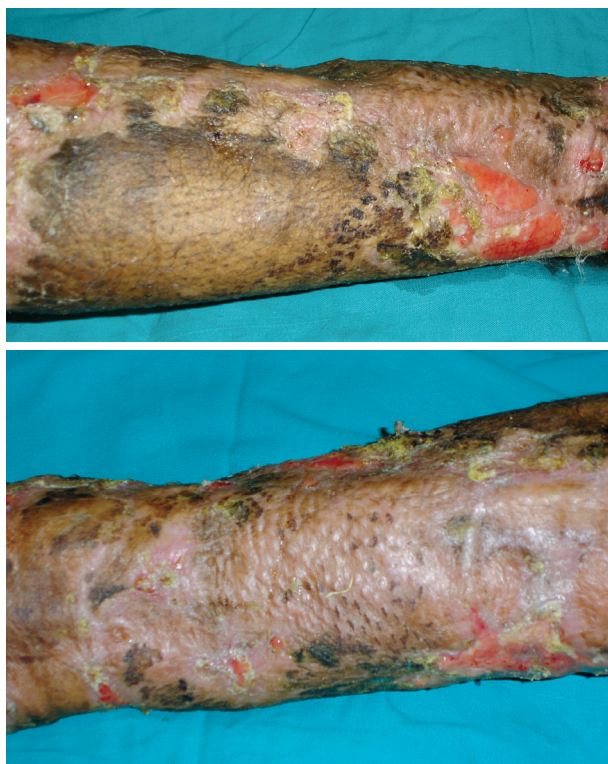


Fig. (7): 12-weeks assessment of cosmetic appearance of grafted chronic wounds in lower limb. Left (above, below): Excision; VSS = 5. Right (above, below): non-Excision; VSS = 3.

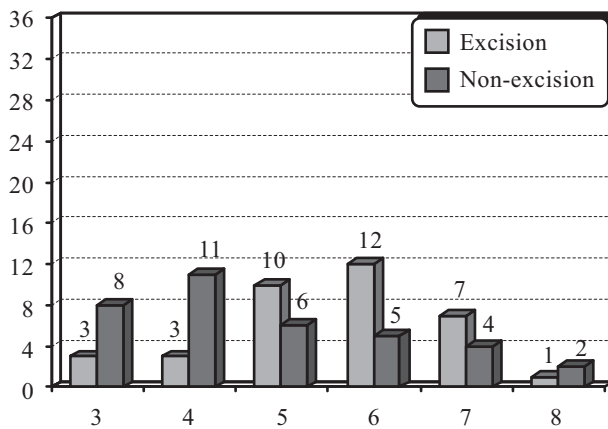


Fig. (8): Scar rating scores of subjects in both groups (VSS); $p < 0.05$ (statistically significant).

DISCUSSION

Reviewing the literature revealed no general consensus on the surgical management of chronic (residual) burn wounds. Studies concerning this issue, especially with respect to the impact of handling granulating bed before grafting on short- and long-term outcomes are scarce, inconsistent, and controversial. Some surgeons are in favour of excising granulation tissue in order to improve graft uptake by refreshing recipient bed [16-18]. In contrast, other surgeons are of the view of direct grafting on intact granulation, thus reducing operative time, inevitable blood loss and the risk of interference with graft uptake by potential haematoma formation [19-23]. All these views are very conflicting and present a controversial issue about the status of intra-operative handling of granulating chronic wound bed. Most of the studies mentioned were not comparative and thus the decision of whether or not to excise granulation tissue prior to grafting has been subjective and mostly dependent on surgeon's experience and expertise. Therefore, the present study aimed at objectively evaluating the impact of handling granulating bed on both short- and long-term outcomes. For this purpose, 72 burned patients with chronic wounds were enrolled in a randomised prospective comparative clinical trial. Two study groups were made to compare the outcome of skin grafting with versus without intra-operative down-to-fascia excision of granulating wound bed. The criteria of evaluation included graft uptake on the overall and with respect to wound chronicity, qualitative bacteriology and pre-operative serum albumin concentration. Long-term assessment of cosmetic appearance of grafted wounds was done 12-weeks post-operatively on the basis of a standard burn scar rating index.

Results showed no statistically significant difference in the mean percent graft uptake between the two study groups. Little is mentioned in the literature concerning the outcome of skin grafting with regard to intra-operative handling of granulating bed of chronic wounds. In a study by Dhar et al., in 2007, comparable results were obtained. However, their study design differed in that graft uptake was compared between ipsi- and contra-lateral sides of the same subject and coverage was postponed for 24 hours during which period harvested grafts were refrigerated in saline-soaked sterile gauze. This was for the purpose of uniformity of comparison and for considering the potential interference with graft uptake by inadequate haemostasis whenever granulating bed is excised [12].

Chronic burn wound for the purpose of the study meant a wound with no evidence of re-epithelialisation within three weeks of primary management. Comparing graft uptake with respect to wound chronicity for up to more than the 60th PBD revealed no statistically significant difference between both study groups. Previous data concerning the impact of handling granulating bed on graft uptake with respect to wound chronicity are insufficient and unclear. Brown and colleagues stated that if the granulations are fresh, then they can be grafted upon directly, but if they were long-standing and fibrous, then they should be removed. However, their study was not comparative and the extent of wound chronicity was not precisely defined. Therefore, their opinion was basically dependent on personal surgeon's experience about the status of granulating bed and thus on its way of handling prior to grafting [24]. It is possible that future research might enable better understanding of the impact of chronicity on the status of granulations with regard to extent of fibrosis, thus allowing further improvement in the outcome of grafting for chronic burn wounds.

Data concerning graft uptake with respect to qualitative wound bacteriology as determined by pre-operative surface swabs were also statistically analysed and compared. There was no significant difference in graft uptake with respect to species of isolates among the same study group. Moreover, there was no significant difference in graft uptake between both groups with respect to species of isolates. These findings clearly indicated that neither surfaces swabs by themselves nor the way of handling granulating bed with respect to species of isolates had an impact on predicting or improving the outcome of grafting for chronic wounds. In the present study, all patients were subjected to quantitative wound biopsies and those having bacterial

counts greater than 105/gm of tissue were excluded from submission for the trial. This goes with many previous reports emphasizing the importance of quantitative bacteriology as determined by 105 threshold in predicting the outcome of grafting for chronic wounds [25,26]. However, there still exists no clear information to correlate between handling granulating bed and quantitative bacteriology as concerns graft uptake in chronic wound management.

Studying the impact of pre-operative serum albumin concentration on the outcome in both study groups revealed significantly lowered graft uptake with albumin less than 4gm% as compared to greater than 4gm% in those patients who were subjected to down-to-fascia excision of granulating bed. In contrast, it was demonstrated that fluctuation of serum albumin around 4gm% had no impact on the outcome in patients subjected to direct grafting on intact granulating bed. Many previous reports have demonstrated the importance of albumin serum level and supplementation throughout all stages of management of critically-ill burn patients including initial resuscitation, primary and secondary conservative/surgical procedures, as well as remote therapy for chronic wounds [27]. However, none of these studies has precisely verified the correlation between handling granulating bed and pre-operative serum albumin as concerns the outcome of grafting for chronic wounds.

Long-term cosmetic assessment of grafted wounds was performed 12-weeks post-operatively based on the criteria set by Vancouver Scar Scale (VSS). There was a significantly lower mean score among subjects of non-Excision group, meaning a better overall cosmetic outcome as compared to subjects of Excision group. Reports in the literature concerning the issue of graft cosmesis in relation to handling granulating bed are scarce. Dhar and co-workers studied the impact of handling granulating bed on graft cosmesis, but this was for the purpose of assessing symmetry of grafted areas among the same patient using a modified burn scar index rather than the more widely approved (VSS). Their results were controversial as excision led to better though statistically insignificant cosmetic outcome than direct grafting on intact granulations [12].

In conclusion, the overall results of skin grafting with versus without down-to-fascia excision of granulating bed of chronic burn wounds are statistically comparable. However, the need for thorough haemostasis following excision eventually makes the procedure significantly lengthier as compared

to direct grafting on intact granulations. Furthermore, the practice of excision requires optimum (>4gm%) pre-operative serum albumin concentration, careful intra- and post-operative fluid/blood replacement and the results with respect to long-term cosmesis are more in favour with grafting on non-excised granulations. Therefore, in view of the similarity in percent graft uptake among both procedures and considering the complexity of excision for the burn team as well as the relatively compromised long-term cosmesis, it is obviously recommended to shift the balance towards the practice of direct grafting on intact granulations for resurfacing chronic burn wounds. It is obvious that further research is required in order to enable better understanding of the correlation between handling granulating bed of chronic wounds and long-term cosmesis of split-skin grafts.

REFERENCES

- 1- Jackson D.M.: In search of an acceptable burn classification. *Br. J. Plastic Surg.*, 23 (3): 219-26, 1970.
- 2- Kloppenberg F.W., Beerthuis G.I. and Ten Duis H.J.: Perfusion of burn wounds assessed by laser Doppler imaging is related to burn depth and healing time. *Burns*, 27 (4): 359-63, 2001.
- 3- Droog E.J., Steenbergen W. and Sjöberg F.: Measurement of depth of burns by laser Doppler perfusion imaging. *Burns*, 27 (6): 561-8, 2001.
- 4- Hermans M.H.: Results of a survey on the use of different treatment options for partial and full thickness burns. *Burns*, 24 (6): 539-51, 1998.
- 5- Barret J.P., Dziewulski P., Ramzy P.I., Wolf S.E., Desai M.H. and Herndon D.N.: Biobrane versus 1% silver sulfadiazine in second-degree pediatric burns. *Plastic Reconstr. Surg.*, 105 (1): 62-5, 2000.
- 6- Rose J.K., Desai M.H., Mlakar J.M. and Herndon D.N.: Allograft is superior to topical antimicrobial therapy in the treatment of partial-thickness scald burns in children. *J. Burn Care Rehabil.*, 18 (4): 338-41, 1997.
- 7- Vloemans A.F., Soesman A.M., Kreis R.W. and Middelkoop E.: A newly developed hydrofibre dressing in the treatment of partial-thickness burns. *Burns*, 27 (2): 167-73, 2001.
- 8- Vloemans A.F., Soesman A.M., Suijker M., Kreis R.W. and Middelkoop E.: A randomised clinical trial comparing a hydrocolloid-dressing and glycerol-preserved allograft skin in the management of partial thickness burns. *Burns*, 29 (7): 702-710, 2003.
- 9- Tompkins R.G., Burke J.F., Schoenfeld D.A., Bondoc C.C., Quinby W.C. and Behringer G.C.: Prompt eschar excision: A treatment system contributing to reduced burn mortality. *Ann. Surg.*, 204-272, 1986.
- 10- Yamamoto H., Siltharm S., De Serres S., Hultman C.S. and Meyer A.A.: Immediate burn wound excision restores antibody synthesis to bacterial antigen. *J. Surg. Res.*, 63: 157-62, 1996.

- 11- Hart D.W., Wolfe S.E., Chinkes D.L., Beauford R.B., Mlcak R.P., Heggers J.P., Wolf R.R. and Herndon D.N.: Effects of early excision and aggressive enteral feeding on hypermetabolism, catabolism and sepsis after burns. *J. Trauma*, 54: 755-764, 2003.
- 12- Dhar S., Saraf R., Gupta A.K. and Raina B.: Comparative study of skin grafting with and without surgical removal of granulation tissue in chronic burn wounds. *Burns*, 33 (7): 872-878, 2007.
- 13- Huang Y., Li X., Zhang G., Liu Q., Tang J., Peng Y., Liu X. and Luo Q.: A randomised comparative trial between Acticoat and SD-Ag in treatment of residual burn wounds, including safety analysis. *Burns*, 33 (2): 161-166, 2007.
- 14- Lund C.C. and Browder N.C.: The estimate of area of burns. *Surg. Gynecol. Obstet.*, 79: 352-8, 1944.
- 15- Sullivan T., Smith J., Kermode J., McIver E. and Courtemanche D.J.: Rating the burn scar. *J. Burn Care Rehabil.*, 11 (3): 256-60, 1990.
- 16- Blair V.P. and Brown J.B.: The use and uses of large split skin grafts of intermediate thickness. *Surg. Gynecol. Obstet.*, 49 (1): 82-97, 1929.
- 17- Brown J.B., Byars Louis T. and Blair V.P.: A study of ulcerations of lower extremity and their repair with thick split skin grafts. *Surg. Gynecol. Obstet.*, 63 (3): 331-40, 1936.
- 18- Ackman D., Gerrie J.W., Pritchard J.E. and Mill E.S.: A report on the management of burns using the occlusive compression with sulfadiazine emulsion. *Ann. Surg.*, 119 (2): 167-77, 1944.
- 19- Pollock William J. and Parkes James C.: Open skin grafting of war wounds. *J. Bone Joint Surg.*, 51-A (5): 926-34, 1969.
- 20- Harlanstone H., Fabian Timothy C., Turklson Margaret L., et al.: Management of acute full thickness losses of the abdominal wall. *Ann. Surg.*, 193 (5): 612-8.
- 21- Rudolph R. and Ballantyne D.L.: Skin graft. In: McCarthy Joseph G., editor. *Plastic Surgery*, Vol. 1. Philadelphia: WB Saunders Company, p. 221-74, 1990.
- 22- McGregor Alan D.: Free skin grafts, Chapter 3. In: McGregor Alan D., editor. *Fundamental techniques of plastic surgery*. 10th ed., Churchill Livingstone: Harcourt Publishers Ltd., p. 35-59, 2000.
- 23- Fraulin Frankie O.G., Illmayer S.J. and Tredget E.E.: Assessment of cosmetic functional results of conservative versus surgical management of facial burns. *J. Burn Care Rehabil.*, 17 (1): 19-29, 1996.
- 24- Brown J.B. and McDowell F.: Massive repair of burns with thick split skin grafts. *Ann. Surg.*, 115 (4): 658-74, 1942.
- 25- Basak S., Dutta S.K., Gupta S., Ganguly A.C. and De R.: Bacteriology of wound infection: Evaluation by surface swab and quantitative full thickness wound biopsy culture. *J. Ind. Med. Assoc.*, 90: 33-5, 1992.
- 26- Uppal S.K., Ram S., Kwatra B., Grag S. and Gupta R.: Comparative evaluation of surface swab and quantitative full thickness wound biopsy culture in burn patient. *Burns*, 33 (4): 460-63, 2007.
- 27- Cochran A., Morris S.E., Edelman L.S. and Saffle J.R.: Burn patient characteristics and outcomes following resuscitation with albumin. *Burns*, 33 (1): 25-30, 2007.