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Early excision and grafting versus delayed excision and grafting of deep thermal burns up to 40% total body surface area: A comparison study

Dr. Rishiraj Yadav, Dr. Hiren Rana, Dr. Salesh Kumar Soni, Dr. MF Shaikh
B.J. Medical College, Civil Hospital. Ahmedabad, Gujarat, India

Abstract
This is a study of 120 patients of either sex and all ages who had sustained deep burns of up to 40% of the total body surface area. Half the patients underwent early excision and skin auto grafting (i.e., within 4-7 days of sustaining burn injury) while the rest underwent delayed excision and skin auto grafting (i.e., within 1-4 weeks post-burn). Significant differences were found in favor of the early excision and grafting group with regard to the various burn management outcome parameters taken into consideration, i.e. culture positivity of wounds, graft take, duration of post-graft hospitalization, and mortality.

Keywords: grafting, deep thermal burns, body surface area

Introduction

Deep burns constitute a challenging form of surgical lesion, typically characterized by three vertical zones of tissue insult. The area closest to the heat source coagulates, and the tissue in this zone is either necrotic at the very outset or it undergoes severe protein denaturation and becomes irreversibly damaged. Just below this coagulation zone is a zone of stasis and edema. Further underneath is an area of hyperemia, where blood flow gradually increases, peaking at about 7 days post injury. A burn that appears superficial at the outset may become deeper over the next of 48-72 h, with the zone of stasis becoming necrotic. This will ensue particularly if the wound becomes infected or there is poor perfusion of the affected area [1-3].

Cope *et al*. [4] Pioneered the concept of early excision and auto grafting of burn wounds after treating patients from the Cocoanut Grove fire in Boston in 1942. Janzekovic5 generated renewed interest in early excision in 1970 when she reintroduced the concept of tangential excision of the necrotic tissue and immediate resurfacing with split-thickness skin grafts. Excision and grafting is now the standard surgical management of deep burns. The goal is to excise all devitalized tissue and render the wound suitable for skin grafting. All layers of necrotic tissue are excised until a viable wound bed is reached, as indicated by capillary bleeding [6-8].

At our burn center, we routinely practice early excision of deep burns in patients who present to us directly. In addition to these patients, we also manage delayed referrals from other hospitals located in far-flung areas of the country. This group of patients has often received initial resuscitation and conservative treatment with traditional dressings for over a week, before being referred to us. In those patients, we perform delayed excision and grafting. The aim of this study is to compare the outcome in patients managed with early excision and auto-grafting versus delayed excision and auto grafting.

Materials and Methods

This prospective observational study was carried out in Department of Burns and Plastic Surgery, Civil Hospital, Ahmedabad, over a period of two years (June 2015-May 2017). It included a total of 120 patients of both genders and all ages who had sustained deep thermal burns of up to 40% of the total body surface area (TBSA) and undergone excision followed by skin auto grafting. Patients with an inhalation injury, electrical, chemical, and radiation burns, and those with any pre-existent chronic illness were excluded. Initial assessment was made by history, physical examination and necessary investigations. As per hospital protocol, informed consent was taken from all patients or their attendants to undergo surgical management and participate in the study. Convenience sampling technique was employed: patients presenting early had early excision and grafting (E&G), while those presenting late had delayed excision and grafting (D&G). As the study was observational and did not involve any new intervention, it was conducted in accordance with the Declaration of Helsinki of 1975, as revised in 2008, and anonymity of the participants was ensured.

Table 1: Demographic and other characteristics of patients in the two groups (n = 120). E&G = early excision and grafting; D&G = delayed excision and grafting

Series number	Patients' characteristics	E&G group (n = 60)	D&G group (n = 60)
1	Age (yr)	29.1 ± 14.3	28.8 ± 14.4
2	Male	36	37
	Female	24	23
3	Percentage TBSA burned	30.6 ± 8.6	30.5 ± 8.6

Table 2: Pattern of wound cultures among burn patients in the two groups (n = 34). E&G = early excision and grafting; D&G = delayed excision and grafting

Series number	Organisms cultured	Number of patients (E&G group)	Number of patients (D&G group)	*p* (%)
1	*Pseudomonas aeruginosa*	1 (1.66%)	22 (36.66%)	p < 0.05*
2	*Klebsiella pneumoniae*	-	4 (6.66%)	p >0.05**
3	*Staphylococcus aureus*	-	3 (5%)	p >0.05**
4	*MRSA*	-	3 (5%)	p >0.05**
5	*Candida albicans*	-	3 (5%)	p >0.05**
6	*E. coli*	-	2 (3.33%)	p >0.05**
7	*Proteus*	-	2 (3.33%)	p >0.05**

* *p* significant = <0.05, ** *p* not significant = *p* >0.05

Half the patients underwent early excision and skin auto grafting E&G (i.e., within 4-7 days of sustaining burn injury). These made up the E&G group of the study. The remaining half were managed with delayed excision and skin auto grafting (i.e., within 1-4 weeks of sustaining burn injury). They made up the D&G group of the study. The two groups matched for age, gender, and TBSA burned (*Table I*). Initially, all patients were resuscitated and optimized on standard management outlines. At the time of surgery, a power dermatome was used to perform thorough surgical excision of all devitalized tissue and tissue specimens were collected for cultures.

Split thickness skin grafts were harvested from unaffected areas, especially the lower limbs and abdomen. All excised wounds were reconstructed with intermediate thickness STSG (0.012-0.015 inch). All skin grafts were meshed in a 1.5-3:1 ratio. The skin grafts were applied on the wound beds and secured in place with staples. The skin grafts were covered with nonadherent Sofratulles and bulky absorbent dressings. Dressings were maintained until day 5 postop. In order to avoid the development of shearing forces on the grafted wounds, patients were kept on strict bed rest. On day 5, the dressings were removed and the wounds were inspected macroscopically to establish the graft take pattern. Graft take was measured as the percentage of grafted surface area where the graft had taken in relation to the burn wound bed, and the graft take pattern was stratified in the following three categories: "Good take" (≥ 95%), "Fair take" (80-95%), and "Poor take" (<80%).

Statistical analysis

The data were analyzed by SPSS version 10. Various descriptive statistics were used to calculate frequencies, percentages, means, and standard deviation. Numerical data, such as age and duration of post-graft hospital stay, were expressed as mean ± standard deviation, while categorical data, such as the organisms cultured, were expressed as frequencies and percentages. The percentages of various outcome variables were compared by employing chisquare test, and a *p* value of less than 0.05 was regarded statistically significant.

Results

Out of a total of 120 patients, 73 (60.8%) were males and 47 (39.2%) were females. *Table I* summarizes the age, gender, and TBSA burned in the two groups of patients.

The initial tissue culture of the wounds sent at the time of excision and grafting showed organism growth in one E&G patient and in 35 D&G patients. The most commonly found organisms were *Pseudomonas aeruginosa* (23 times), *Klebsiella* (4), *Staphylococcus aureus* (3), methicillin-resistant *Staphylococcus aureus* (MRSA) (3), *Candida albicans* (3), *E. coli* (2), and *Proteus* (2). Double organisms were cultured in four patients (*Table II*).

Table 3: Take pattern of split thickness skin graft among burn patients in the two groups (n = 60 each group). E&G = early excision and grafting; D&G = delayed excision and grafting

Series number	Graft take (%)	Number of patients (E&G group)	Number of patients (D&G group)	*p* (%)
1	Good (≥ 95%)	54 (90%)	13 (21.66%)	*p* < 0.05*
2	Fair (80-94%)	5 (8.33%)	34 (56.66%)	*p* < 0.05*
3	Poor (< 80%)	1 (1.66%)	13 (21.66%)	*p* < 0.05*

* *p* significant = <0.05

Table 4: Post-graft duration of hospital stay among burn patients in the two groups (n = 60 each group)

Series number	Post-graft duration of hospital stay (%)	Number of patients (E&G group)	Number of patients (D&G group)	*p* (%)
1	Up to 7 days	54 (90%)	13 (21.66%)	*p* < 0.05*
2	8-14 days	6 (10%)	37 (61.66%)	*p* < 0.05*
3	> 14 days	–	10 (16.66%)	*P* >0.05**

**p* significant = <0.05; ** = not significant

Table 5: Mortality (n = 4)

Series number	Patients' characteristics						
	Age (yr)	Gender	TBSA burned (%)	Day after sustaining injury excision/ STSG performed	Graft take pattern	Day of death after excision/STSG	Remark/ Reason of death
1	11	Male	27	Day 14	Fair	Post-op day 11	Sepsis
2	34	Male	40	Day 24	Poor	Post-op day 20	Sepsis
3	25	Female	30	Day 28	Poor	Post-op day 14	Sepsis
4	48	Male	35	Day 23	Poor	Post-op day 28	Sepsis

Necrotic and inflamed tissues are removed, and resurfacing with normal skin is performed. Eschar, being the principal nidus for bacterial infection, is removed. The subsequent skin grafting in turn reduces fluid loss and metabolic demand, and protects the wound from exposure to infectious organisms. Thus, early excision and grafting reduce inflammation and also avert the risk of infection, wound sepsis, and multiorgan failure.

If surgery is not performed or is delayed in patients with deep burns, this will have its consequences. In the past, patients with burns used to be treated with dressings and topical antimicrobial agents for weeks until the eschar separated spontaneously. If the patient survived, the granulating wound would then be covered with split thickness skin graft, a process that could take 3-5 weeks. Patients with severe burns treated in this way, particularly those with over 20% TBSA burns, were more likely to die of sepsis due to the massive release of inflammatory mediators from the burn. This was further exacerbated by subsequent infection of the wounds. With the traditional approach, patients' hospital stay was prolonged, and patients were more liable to develop problems like hypertrophic scarring and contractures due to the problems associated with delayed wound healing [5, 6, 8].

In our study, culture positive wounds were more frequent in the delayed excision group. Subrahmanyam [11] also reported fewer positive wound cultures and a statistically significant shorter duration of antibiotic treatment among patients who had early excision and grafting. Barrett *et al*. [12] found that removing the burn eschar eliminated the source of wound infection. The devitalized tissue not only increased its bacterial and fungal colonization but also induced bacterial and fungal invasion into subcutaneous viable tissues.

In our study, graft take in our patients was significantly better with early excision. We also had a significant shortening of post-graft hospital stay in patients who had undergone early excision and grafting. Our findings are consistent with those of Xiao-Wu *et al*., [10] who found that delayed excision and grafting were associated with longer hospitalization and increased rates of invasive wound infection and sepsis in the group undergoing surgery [7-14] days post-burn. Other published literature has reported similar findings [12-14].

In our study early excisions were performed on days [4-7]. The optimum time for early excisions continues to be debated. Many studies have reported that burn excision can be started after initial assessment and once stabilization has been achieved (which takes 48-72 h) and also that excision can be performed while the patient's general management proceeds.5 Despite these findings, the literature does not give a conclusive answer as to which treatment protocol is optimal. Barrett *et al*. [12] Demonstrated that all severe burns should be excised within 48 h for fully beneficial effects. Herndon *et al*.,16 in a prospective series, examined burns of greater than 30% TBSA, and found significantly reduced mortality with early excision (within 72 h) in patients aged 17-30 yr. with no inhalation injury. However, they did not find any difference in mortality in patients over 30 years of age.

Ong *et al*., [8] in a meta analysis of six randomized, controlled trials, published from 1966 through 2004, comparing early excision of burns versus conservative approaches, found a trend towards reduced mortality thanks to early excision. Pavoni *et al*. [9] Found that, in addition to several other factors, any delay in the timing of the first escharectomy was a significant contributor to patients' mortality. Khadjibayev *et al*. [7] Found that improved results in the surgical treatment of deep burns were linked to the wide application of active surgical tactics.

In our study, the blood transfusion requirements in the two groups of patients were comparable. Khadjibayev *et al*. [7] Reported increased blood after 16 days, since that was a blunt debridement of a granulating bed rather than a sharp removal of adherent eschar as it is the case in early excision.

Hopefully our study will prompt other similar local studies and thus permit a more meaningful comparison of the results in our own population and we therefore recommend carrying out a multicenter local study to confirm and improve upon our results. A local study would also be useful to compare the overall cost of management with E&G versus the cost with D&G, thereby producing concrete evidence confirming that E&G is an economical alternative to D&G, particularly in the context of a developing country like ours.

Limitations of the Study

Our study presents some limitations. It is a single center study. Randomization and blinding of the patients or of treating doctors was not possible, so observer bias could not be eliminated completely. Ideally, a well-designed randomized controlled trial should have been conducted but it would have been non-ethical to deprive patients of the known benefits of early excision. In our study, exact matching of the two groups with respect to initial topical wound care or initial fluid resuscitation could not be done, as these confounders were beyond our control in late admissions. Inadequate initial management of these patients probably resulted in higher infection rates. We estimated the graft take pattern by gross inspection without employing a blinded investigator, and there may therefore have been an element of observer bias. Likewise, we could not evaluate cosmetic or long term functional results from the two management approaches.

Recommendations

On the basis of this evidence, we recommend launching educational programs to raise doctors' awareness of the

importance of early surgical excision of deep burns in order to avert the subsequent morbidity resulting from pit- falls in the early management of burns. As burn surgery continues to be a largely neglected area of plastic surgery in both the public and the private sector hospitals in our country, we strongly recommend establishing improved facilities for acute burn management and for rehabilitation throughout the country. Dedicated and well-trained professionals are needed to ensure proper surgical management of burns in our country. We also need to develop national guidelines that are consistent with our local circumstances.

Conclusion

Early excision and grafting should be employed in the management of deep burns given their significant ad- vantages compared with traditional conservative management.

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