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Impact of Early versus Delayed Excision and Grafting on Wound Healing and Treatment in Burn Injuries: A Retrospective Study

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ABSTRACT

Background: Injuries from burns have an important effect on public health, especially in low- and middle-income nations, resulting in substantial mortality, morbidity and economic loss. The timing of excision and grafting is a key aspect in patient outcomes especially when it involves hypertrophic formation of scars. **Methods:** This retrospective study, performed at a top burn therapy centre in Islamabad, Pakistan, investigated the medical histories of patients who had been treated for deep cutaneious or full thickness burns. Patients were separated into two groups based on when they received their surgical intervention: early excision and grafting (EEG) within a week after damage and delayed excision and grafting (DEG) after one week. The primary outcome studied was the frequency and seriousness of hypertrophic scar development, which was determined using a conventional scar evaluation scale. **Results:** The study examined 100 patients and found that those enrolled in the EEG group had considerably better outcomes in terms of hypertrophic scar formation, hospital stay duration, rates of infection, and overall treatment expenses compared to the DEG group. The study emphasized the significance of early surgical treatments in improving burn treatment outcomes and the need for dedicated burn care facilities. **Conclusion:** Early excision and grafting within one week of suffering a burn injury greatly minimize the risk and severity of hypertrophic scars, decrease stays in the hospital, and reduce the incidence of infection and treatment costs.

INTRODUCTION

Severe burns are a major public health concern in countries with low or middle incomes, resulting in severe economic loss. Historically, burn victims were frequently treated with topical antibiotic medicines and bandages until the eschar, or dead tissue, gradually sloughed off. A divided thickness kin graft is often put to the granulating wound, a process that takes between three and five weeks to complete. (1). Hypertrophic scarring after burn injuries is a difficult issue in plastic, dermatological, and reconstructive procedures, drastically reducing survivors' quality of life. Scar formation is influenced by the initial extent and severity of the wound, genetic variables, and most importantly the timing of surgical procedures such as excision and grafting. (2).

It is suggested to rapidly remove and graft deeper burns to reduce scar severity, since prompt action may help attenuate excessive formation of scars. (3). Effective burn damage management

therapy, along with rigorous wound care and painful surgeries such as wound debridement. (4). The pathogenesis of hypertrophic scarring is inextricably linked to the wound healing process, in which an excessive fibrotic reaction causes elevated, frequently painful or itchy scars. Delayed excision and grafting, while permitting cautions tissue assessment, may unintentionally prolonged the period of inflammation and aggravate scar development. (5) Scar emergence is a serious issue for both physicians and patients. Emerging medicines addressing specific cellular and molecular processes show promise in alleviating fibrotic illnesses. (6) Different surgical techniques to burn wound treatment have an impact on patient outcomes, with early excision and grafting being particularly important to decrease hospital admissions, infection rates, and metabolic abnormalities. While current treatments like hydro-surgery assisted wound healing offer precision and tissue preservation, their influence on scar formation is uncertain. (7)

Burn injuries continue to be a significant reason for emergency room visits, emphasizing the significance of spreading awareness about burn care. Interdisciplinary teamwork among healthcare experts is essential for improving burn therapy while considering patient demands and available resources. (8). Burn injuries were traditionally treated medically until the middle of the twentieth century, when surgical procedures gained prominence. Early phased excision, which begins within days of injury, has transformed burn therapy, dramatically lowering morbidity and fatality rates. This strategy, informed by knowledge into burn wound pathogenesis and systemic inflammatory reactions, emphasizes the necessity of prompt action in improving outcomes for patients. (9) Our study will assess the effects of early and delayed excision and grafting on burn patients. As a developing nation with a shortage of resources, we must create strategies for burn injury management that will save time, money, and resources in sensitive circumstances such as burns.

METHODOLOGY

The purpose of the present retrospective study was to determine the impact of when to perform of excision and grafting procedures on the development of hypertrophic scars in patients with deep dermal or full thickness burn injuries. The analysis was carried out by thoroughly reviewing records of patients from a top burn treatment centre in Islamabad, Pakistan. The cohort under research included individuals who had received therapy for deep dermal and full thickness burns and underwent excision and grafting operations. Patients having thorough medical records including the exact moment of surgical operations, the depth and extent of the burns, and at least six months of postoperative follow-up data were included in the study. Individuals with incomplete records, no follow up data, or previous medical history that could interfere with wound healing were excluded from the study. A comprehensive examination of patient documentation enables the categorization of participants into two distinct groups based on the timing of their excision and grafting procedures: an early excision and grafting group (EEG), where surgery was performed within a week of the injury, and a delayed excision and grafting group (DEG), where surgery was performed more than one week after the injury had occurred. The primary measure of outcome was the frequency and severity of hypertrophic scar development, which were quantitively assessed using the standardized Scar Assessment Scale, which considers scar height. Pliability, coloration, and blood circulation. Statistical studies were rigorously conducted to determine the differences in outcomes connected to early vs delaying surgeries.

The occurrence and severity of hypertrophic scars were studied in the EEG and DEG groups. To account for potential confounding variables such as age, gender, the total area of the body affected, and burn depth, the method of multivariate regression was used. Furthermore, the relationship between the timing of excision and grafting and scar outcomes was studied using logistic regression for incidence data and linear regression analysis for severity measures. This study's retrospective design eliminated the need for patient consent for inclusion, but strict confidentiality protocols were maintained to protect identities of patients and sensitive medical data.

RESULTS

The study's analysis, encompassing data from 100 patients distributed between the early excision and

grafting group (EEG) and the delayed excision and grafting group (DEG), revealed significant findings regarding the impact of surgical intervention timing on hypertrophic scar formation.

Table 1
Baseline Characteristics

Variable		Frequency	Percentage
Gender	Male	38	38.0
	Female	62	62.0
Burn Mechanism	Electric shock	1	1.0
	Chimney	20	20.0
	Explosion	14	14.0
	Fell into fire	2	2.0
	Gas explosion	38	38.0
	Fire due to short circuit	23	23.0
	Vehicle explosion	2	2.0
Number of Burns	Single	41	41.0
	Multiple	59	59.0
Hospital Admission	Yes	93	93.0
	No	7	7.0
Location for Worst Burn Injury	Not Reported	28	28.0
	Arm	13	13.0
	Back	3	3.0
	Face	3	3.0
	Foot	6	6.0
	Hand	27	27.0
	Head and Neck	2	2.0
	Leg	13	13.0
	Neck	5	5.0
EEG or DEG	Not Reported	7	7.0
	Early excision and Graft (EEG)	48	48.0
	Delayed excision and Graft (DEG)	45	45.0
Blood Transfusion	No	32	32.0
	Yes	68	68.0
Inhalation Injury	No	28	28.0
	Yes	72	72.0
Ambulance transfer	No	25	25.0
	Yes	75	75.0
Comorbid	No comorbid	11	11.0
	Anaemia	19	19.0
	Arthritis	10	10.0
	Hypertension	19	19.0
	Diabetes Mellitus	9	9.0
	Previous Heart Attack	8	8.0
	Chronic Kidney Disease	9	9.0
	Vascular Disease	15	15.0
Graft Size	Not Reported	7	7.0
	Fat Dermis	33	33.0
	Full Thickness	29	29.0
	Split Thickness	31	31.0
Sugar Level	No Surgery	7	7.0
	Minimal Invasive Procedure	33	33.0
	Minimal to moderately invasive procedure	4	4.0
	Moderately Invasive Procedure	22	22.0
	Highly Invasive Procedure	34	34.0
Wound Complications	Cellulitis	21	21.0
	Infected Bone Flap	39	39.0
	Mucocele	15	15.0
	Oronasal fistula	25	25.0
Scar formation during healing	Not Reported	7	7.0
	Yes	44	44.0
	No	49	49.0
Overall Function at Follow-up	Improvement	47	47.0
	No Improvement	53	53.0
Pigmentation at Follow-up	No pigmentation	8	8.0
	Spots	35	35.0
	Melasma	27	27.0
	Generalized pigmentation	30	30.0

The number of females were more than the number of males; they were 62 (62%). The most frequent event that led to the burn was gas explosion (n=38, 38%) and the hands were reported to have the burns of worst severity (n=27, 27%)

The significant factors associated with scar formation were identified through chi-square test. The test variables are stated in table 2.

Table 2
Test for significant variables that affect the scar formation

		Scar Formation			Total	
		NR	Yes	No		
Gender	Male	1	19	18	38	0.332
	Female	6	25	31	62	
Burn Mechanism	Electric shock	0	0	1	1	0.664
	Chimney	1	9	10	20	
	Explosion	1	4	9	14	
	Fell into fire	0	2	0	2	
	Gas explosion	4	16	18	38	
	Fire due to short circuit	1	13	9	23	
	Vehicle explosion	0	0	2	2	
Number of Burns	Single	1	25	15	41	0.012
	Multiple	6	19	34	59	
	Not Reported	7	4	17	28	0.002

Location for Worst Burn Injury	Arm	0	4	9	13	
	Back	0	2	1	3	
	Face	0	2	1	3	
	Foot	0	5	1	6	
	Hand	0	13	14	27	
	Head and Neck	0	2	0	2	
	Leg	0	8	5	13	
	Neck	0	4	1	5	
EEG or DEG	Not Reported	7	0	0	7	0.000
	Early excision and Graft	0	7	41	48	
	Delayed excision and Graft	0	37	8	45	
Comorbid	No comorbid	2	1	8	11	0.011
	Anaemia	5	7	7	19	
	Arthritis	0	5	5	10	
	Hypertension	0	9	10	19	
	Diabetes Mellitus	0	2	7	9	
	Previous Heart Attack	0	4	4	8	
	Chronic Kidney Disease	0	6	3	9	
	Vascular Disease	0	10	5	15	
Graft Size	Not Reported	7	0	0	7	0.000
	Fat Dermis	0	18	15	33	
	Full Thickness	0	12	17	29	
	Split Thickness	0	14	17	31	
Surgery Level	No Surgery	7	0	0	7	0.000
	Minimal Invasive Procedure	0	16	17	33	
	Minimal to moderately invasive procedure	0	4	0	4	
	Moderately Invasive Procedure	0	9	13	22	
	Highly Invasive Procedure	0	15	19	34	
Wound Complications	Cellulitis	0	10	11	21	0.003
	Infected Bone Flap	0	17	22	39	
	Mucocele	1	10	4	15	
	Oronasal fistula	6	7	12	25	

NR: not reported, EEG: Early excision and Graft, DEG: Delayed excision and Graft

The scar formation was independent of gender and mechanism of burn. But it was significantly associated with number of burns, location for worst burn injury, EEG or DEG, comorbid, graft size, surgery level and wound complications with an asymptomatic p value of less than 0.05.

Apart from being associated with scar formation the early or late intervention can be affected by certain factors and the time of surgery affects the course of healing. The findings are given in table 3.

Table 3
Variables associated with the timing of the surgery

Variables		EEG or DEG			Total	
		NR	EEG	DEG		
Wound Complications	Cellulitis	0	9	12	21	0.0031
	Infected Bone Flap	0	19	20	39	
	Mucocele	1	4	10	15	
	Oronasal fistula	6	12	7	25	
Blood Transfusion	No	7	21	4	32	0.000
	Yes	0	27	41	68	
Overall Function at Follow-up	Improvement	0	6	41	47	0.000
	No Improvement	7	42	4	53	
Pigmentation at Follow-up	No pigmentation	7	0	1	8	0.000
	Spots	0	18	17	35	
	Melasma	0	16	11	27	
	Generalized pigmentation	0	14	16	30	

EEG: Early excision and Graft, DEG: Delayed excision and Graft

The wound complications were more common in delayed excision and surgery group except for the oronasal fistula that was more common in the early excision group. The difference between the two groups was significant (p=0.0031). The need for blood transfusion was more in the delayed surgery group (p=0.000). There was significant improvement in function in the EEG group (p=0.000).

The timing of surgery and scar formation are directly associated, we stratified them against other variables to find the effect of other variables on the relationship and the findings are given in table 4.

Table 4
The stratification of timing and scar formation against other variables

Variable	Stratified Against	Sig.
EEG or DEG and scar formation	Gender	0.000
	Burn Mechanism	0.000
	Number of Burns	0.000

	Location for Worst Burn Injury	0.000
	Comorbid	0.000
	Graft Size	0.000
	Surgery Level	0.000

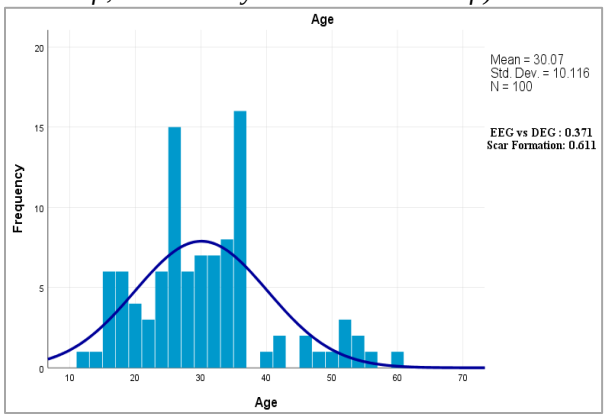
EEG: Early excision and Graft, DEG: Delayed excision and Graft

The stratification was done against gender, burn mechanism, number of burns, worst scar location, comorbid, graft size and surgery level and all of them were positively accelerated the association of timing of surgery and the scar formation. None of these variables showed a negative association.

The continuous variables of age, TBSA and days stayed at hospital were analyzed through one way ANOVA test and the results are given in Figures 1, 2 and 3 respectively.

Figure 1

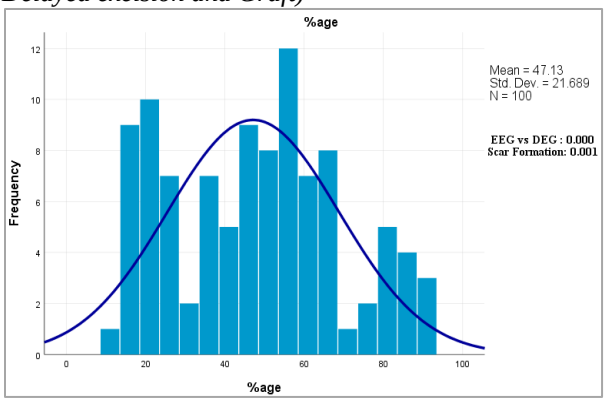
Age of the participants (legends: EEG: Early excision and Graft, DEG: Delayed excision and Graft)



The age of the patient is not related to the time of surgery or the scar formation.

Figure 2

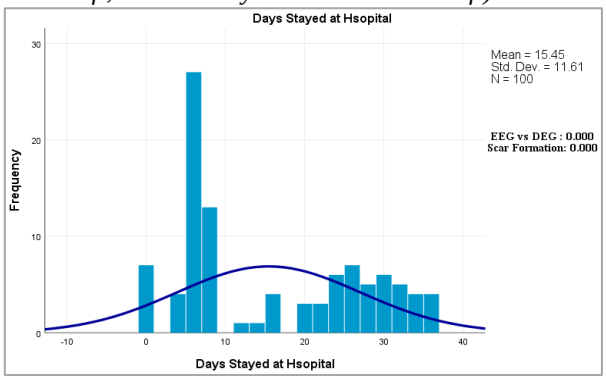
Percentage of the total body surface area burnt (legends: EEG: Early excision and Graft, DEG: Delayed excision and Graft)



Percentage of the total body surface area burnt determines the time of surgery and also can affect the scar formation.

Figure 3

Days stayed at hospital (legends: EEG: Early excision and Graft, DEG: Delayed excision and Graft)



The patients who undergo EEG are less likely to stay at the hospital for longer time, and also the longer stays are related to scar formation.

DISCUSSION

The World Health Organization (WHO) estimated that annually, 180 thousand people out of an estimated 11 million burn cases die owing to burn injuries. Burns represent as complex injuries with a high mortality rate, that require dedicated, expert, and multifaceted management (10). Burn injuries significantly contribute to disease burden, needing both surgical and pharmaceutical interventions in specialized centres leading to an improved survival rate. However, limited resources in low- and middle-income countries (LMICs) necessitates care in non-specialized settings leading to poor management of burn patients (11). Significant advancements in burn care in recent decades has greatly improved survival rates for burn victims. The trend has shifted from mere survival to enabling patients to return to their communities and work places fully functional (12). The past century has witness noticeable reduction in morbidity and mortality from burn injuries (13). Our country is a LMIC, and the burns are a common problem at emergency room.

Burns lead to loss of skin's protective barrier, which permits microbial entry potentially leading to infection. The resultant fluid and mineral loss results in excessive caloric demands, complicating nutrient acquisition and disturbing endocrine function. Furthermore, the situation is aggravated

by oxidative stress caused by free radical activity and inflammation. Adequate antioxidant and nutrient intake are crucial in such cases. Advances in research and clinical practices have markedly improved treatment for thermal injuries. The current therapeutic strategies target various stages and complications that are seen in post thermal injury (14). The exploration of new treatments including scar modulation techniques and laser technology along with mental health interventions and rehabilitation, continues to improve patient outcomes and quality of life for burn victims (13).

Accurate assessment of burn depth is mandatory while choosing between conservative or surgical treatment. Appropriate grafting after wound excision is a preferred method for management. The use of skin allografts plays a crucial role in burn therapy due their physiological and mechanical properties, setting standard of care for burn injury (12). There are debates about the optimal timing for the surgical intervention for deep, partial, or full thickness burns (15). There is consensus on application of immediate and vigorous excision and grafting for extensive, deep burns to enhance survival and reduce complications. However, the superficial and intermediate depth wounds have no clear indication. Advocates for early intervention argue its effectiveness over conservative measures, supported by established links between burn depth, healing duration, and hypertrophic scar risk (16). The Scar formation in the participants of the present study was linked with the healing, and the location of the worst scar.

Severe burns trigger an immediate and extensive hypermetabolic response, characterized by the elevated proinflammatory cytokines and acute phase proteins potentially leading to multi-organ failure or death. Removing dead tissue and eschar promptly reduces this hypermetabolic response, if it is done within 72 hours post injury for certain patients (17). Removing necrotic and inflammatory tissues facilitates skin recovery. Eschar removal significantly lowering bacterial infection risks, fluid loss, and metabolic demands. Delays in treating significant burns, particularly those exceeding 20% total body surface area (TBSA), sepsis and mortality risks due to inflammation (18). Early excision and grafting (EEG) significantly diminish scar formation and contracture development compared to delayed excision and grafting (DEG) (14). The findings of the present study are also in line with the reports from literature.

Studies indicate that in both LMICs and high-income countries (HICs), the hospital stay, and incidence of sepsis are reduced with EEG compared to DEG and have better outcomes. Additional analyses with age in HICs confirmed that mortality rates remained unchanged when the elderly were excluded from the analysis (19). In a comparative study, EEG showcased a higher graft success rate than the DEG group. The duration of hospital stays, and the six-month follow-up outcomes (itch scores and scar quality) were similar in both groups for TBSA of less than 15% (20). A historical cohort in two referral burn centres in Shiraz compared ultra early and early excision and grafting for burns covering up to 60% TBSA. There was correlation between the ultra-early excision and grafting and higher graft success rates (21). Reports have highlighted the benefits of EEG in reducing hospital stays, medical expenses and septic complication with some studies reporting decreased mortality rate. EEG has been considered as standard of care for burns not expected to heal independently within three weeks (22). EEG are believed to offer better functional and aesthetic outcomes results without a significant difference in need for reoperation and scar quality (15). The present study also reported benefit of the EEG in terms of hospital stay, and wound complications.

An analysis of EEG and DEG revealed no significant differences in the number of surgeries, packed cell usage, or fresh frozen plasma usage. However, the EEG group experienced notably shorter hospital stays and lower treatment cost, emphasizing the need for specialized burn care units in both public and private hospital settings to improve patient outcomes and reduce healthcare costs (23). A comparison of EEG and conservative care in facilities with low resources, demonstrated that early intervention significantly reduces hospital stays even in resource-constraint environments, thereby affirming its applicability in outcomes across diverse healthcare settings (24). The EEG group in the present study needed less blood transfusion than the DEG group.

Eschar removal and EEG reduce mortality by decreasing bleeding, infection risks, and energy demands. Delaying necrotomy and skin grafting elevates the risk of wound infection and septic complications. Crucial factors in necrotomy include the extent of excision, blood loss, and skin graft availability, with excisions typically resulting in lesser blood loss compared to GED (25). Treating burn patients within the first three days post injury substantially lowers infection and death risks, highlighting the importance of timely surgical intervention (26). Deep hand burns pose a serious risk due to their potential to cause significant functional impairment, unsightly scarring, and psychological distress. An EEG intervention resulted in improved wound healing, reduced infections, and lessened post-burn contractions, demonstrating its superiority over DEG in terms of graft acceptance, infection rates, contracture development and overall cost effectiveness (27). The functional improvement at follow-up and the state of pigmentation was better in the EEG group suggesting better results with the early surgical intervention.

These observations underscore the pressing need for methodologically rigorous studies focusing on essential patient outcomes to ascertain the most effective timing for burn excision.

CONCLUSION

The retrospective study emphasizes the significant benefits of early excision and grafting for treating severe burns, highlighting reduced hypertrophic scarring and better overall patient outcomes with timely surgical interventions. Conducted at a prominent burn treatment centre in Islamabad, Pakistan, the research showcases the importance of early surgery, within a week of injury, in improving scar quality, shortening hospital stays, and lowering infection rates and treatment costs. The study also underlines the necessity of specialized burn care units to enhance patient recovery and reduce healthcare expenditures, advocating for their establishment across various settings. Conclusively, the findings advocate for the widespread adoption of early surgical strategies and the importance of continuous research and collaboration in burn care to advance treatment methodologies and patient survival rates.

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