



## Comparison of the Results of Early Excision and Grafting between Children and Adults; A Prospective Comparative Study

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### ABSTRACT

**Objectives:** To compare the outcomes of early excision and grafting between pediatric and adult patients with deep burns of less than 40% total body surface area burns (TBSA).

**Methods:** This is a prospective comparative study. Overall, 106 patients admitted to Ghotbodini Burn Center in Shiraz, Iran from September 2012 to September 2013, were included in the study. All patients had less than 40% TBSA burn and had excision and grafting under 14 days from their injury. Patients were divided into two age groups of younger than 14 (n=49) and older than 14 (14-65) years old (n=57). During a 6-month follow-up period, the two groups were compared regarding mean percentage of graft take, total scar score, duration of hospital stay and itching score.

**Results:** During follow-up, the two groups did not show a significant difference in graft take, total scar score and itching score ( $p=0.461$ ,  $p=0.363$  and  $p=0.637$ , respectively). Clinically, the pediatric group showed less hospital stay ( $12.25\pm 9.1$  vs.  $16\pm 12.9$ ), however this was not statistically significant ( $p=0.091$ ).

**Conclusion:** Adults and elderly patients (14–65 years old) compared to pediatric patients (less than 14 years old) with less than 40% TBSA burns, can expect similar results regarding scar score, graft take, itch score and hospital stay, after excision and grafting performed less than two weeks from their initial injury.

**Keywords:** Early excision; Skin graft; Burn; Pediatric; Adult.

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### Introduction

Burn injuries are among the most devastating types of injuries in every population, especially in developing countries [1, 2]. Based on various studies worldwide, cultural and environmental factors

affect burn injuries. Improvement in burn care, fluid resuscitation, better nutritional regime, use of topical antimicrobial agents, better rehabilitation and surgical methods such as early excision and grafting in comparison to more conservative approaches, have led to better survival and overall recovery in

both children and adults [1, 3].

Different factors are believed to play a role in the morbidity and mortality related to burn injuries including total body surface area (TBSA) of the burn, type of burn (specifically inhaled injuries) and the age of the burn victim [4, 5].

Based on the pathophysiology of burn injuries and physiology of wound healing, compared to younger individuals, it is expected that older individuals to be at higher risks of complications, having slower recovery rates and increased hospitalization rates [6]. Tuvdendorj *et al.*, [7] reported a better net protein balance among a pediatric population compared to an elderly population after an initial muscle protein breakdown due to a burn injury. On the other hand, some studies have documented no correlation between age and burn scar related problems [8].

Nowadays, with critical advances in the management of burn patients, complication rates after surgery for these patients has dropped dramatically, although this drop has been milder in older patients [9]. Nevertheless, understanding the difference between wound healing in children and adults will guide us to consider different management programs for these two groups. In this study, we evaluated the outcomes of excision and grafting between a pediatric and an adult group of burn patient, in order to clarify healing differences between these two age groups.

## Materials and Methods

### *Study Protocol and Patients*

This is a prospective comparative study performed in Ghotbodini burn center in Shiraz, Iran. All patients who referred to the burn center during September 2012 to September 2013 that met our inclusion criteria, were considered for inclusion in the study. Any patient between the ages of 1 to 65 years who had deep second and third degree burns covering less than 40% TBSA was included in the study. The exclusion criteria for both the pediatric and adult group consisted of respiratory injury, connective tissue disorders, immune suppressive disorders, scars of previous burn injuries, severe protein malnutrition, associated injuries, severe systemic diseases such as diabetes and advanced cardiovascular disease, and use of medication that would affect epithelialization.

Patients were divided into two categories based on their age: patients less than 14 years old (considered for the pediatric group) and patients older than 14 years old (considered for the adult group). Among those younger than 14 years old, 50 patients were randomly selected to enter the pediatric group and among those older than 14 years old, 57 patients were randomly selected to enter the adult group, using simple random sampling.

### *Procedures and Follow-Up*

After achieving hemodynamic stabilization, all patients were operated during the first 14 days after

the initial burn. Under general anesthesia and in sterile conditions, the burnt tissue was excised to achieve a proper surface for grafting. The wound was then covered with a split thickness skin graft (with 1.5-1 and 3-1 meshing) simultaneously and fixed with skin staplers. The excision and grafting were all performed in the same session. The dressings were removed five days after grafting. The patients were visited weekly during the first month and then monthly for the following five months. During the six months of follow-up, the two groups were compared in terms of mean percentage of graft take, total scar score, duration of hospital stay and itching score.

### *Definition of Variables*

In this study we defined “early excision and grafting” as less than two weeks from the initial injury. The Vancouver scale was used to assess the scar in the two groups. The scale scores the patients from 0 to 13 based on four factors of pigmentation, pliability, vascularity and height of scar tissue. A score of 0 represents no scarring and a score of 13 represents severe scar formation [10]. Itch score was measured using the 5-D scale, which gives patients an overall score of 5–25. Based on this scale patients are scored on duration, degree, direction, disability and distribution of their pruritus [11]. Amount of graft take was determined through observation by the same surgeon who was blinded to the study protocol. A successful graft take was defined as a pink, dry graft with blanching.

Aside to the graft take, all other evaluations were done by the same surgeon who was unaware of the study design.

### *Ethical Consideration*

The study was affiliated with Shiraz University of Medical Sciences and the study protocol was approved by both the Institutional Review Board (IRB) of Shiraz University of Medical Sciences. All participants gave their informed and written consents to enter the study.

### *Statistical Analysis*

For data analysis the Statistical Package for Social Science, SPSS® for Windows®, version 11.5 (SPSS, Chicago, IL) was used. For comparison of means between two groups without a normal distribution, the Mann-Whitney test and for comparison of means before and after surgery, the Wilcoxon test was utilized. The results are presented as means ± standard deviations and median and interquartile range, where appropriate. A two-tailed p-value of less than 0.05 was considered statistically significant.

## Results

From the initial 107 patients, one patient was lost in the follow-ups and statistical analysis was performed on 106 patients. Figure 1 displays diagram for the

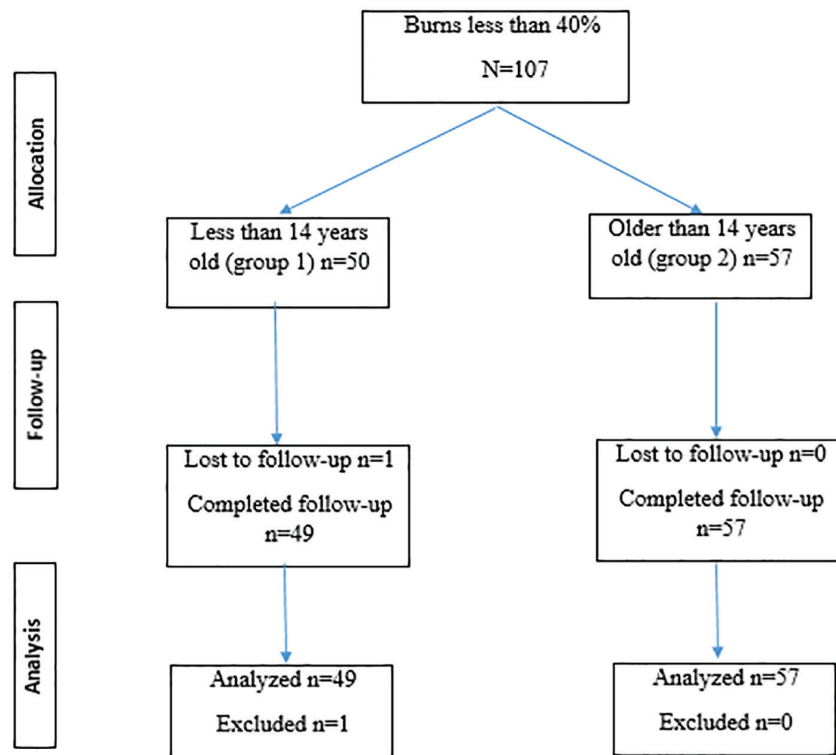


Fig. 1. Diagram for the allocation of patients in the two groups.

classification and allocation of patients in the two groups. Surgery related characteristics including total burn size and total graft size were similar between the two groups ( $p>0.05$ ) (Table 1).

During the postoperative period, although not statistically significant, the adult group demonstrated longer hospital stays ( $16\pm 12.9$  vs.  $12.25\pm 9.1$  for the adult and pediatric group, respectively;  $p=0.091$ ). There was no significant difference regarding total scar score between the pediatric and adult groups ( $4.63\pm 3.63$  and  $3.92\pm 3.25$ , respectively;  $p=0.363$ ).

Percentage of graft take was high in both groups and only 25% of patients demonstrated 90% or less success in graft take. Percentage of graft take did not show a significant difference between the two groups ( $92.38\pm 8.3$  and  $93.6\pm 7.1$  for the pediatric and adult group, respectively;  $p=0.461$ ).

There was no significant difference in itching score

between the two age groups ( $0.9\pm 1.24$  and  $1\pm 1.26$  for the pediatric and adult groups, respectively;  $p=0.637$ ) (Table 2).

**Discussion**

The goal of our study was to compare different clinical aspects of burn related wound healing between pediatrics and adults burn patients after surgery. For this purpose, we compared the results of wound healing after early excision and grafting (less than 14 days after initial injury) between two age groups of younger than 14 and older than 14 years old burn patients. We selected patients with burns of total body surface area less than 40% to exclude systemic effects of larger burns and their related complications on wound healing. Our results showed that, contrary to our expectation, regarding

Table 1. Patients’ baseline and surgery related characteristics.

Variables	Pediatric group (age ≤ 14) n=49			Adult group (age>14) n=57			p-value	
	Mean±SD	Median	IQR 25 75 percentile percentile	Mean±SD	Median	IQR 25 percentile 75 percentile		
<b>Sex - no. (%)</b>								
<b>Male</b>	25 (51)			23 (40.4)				
<b>Female</b>	24 (49)			34 (59.6)				
<b>Total burn size (%)<sup>a</sup></b>	16.45±11.65	16.00	6 25	18.41±12.91	19.50	7.25 29.50		0.453
<b>Total graft size (%)<sup>b</sup></b>	11.83±9.78	8.50	4 20	13.37±10.92	10	4 20		0.527

<sup>a</sup>Data of 6 patients in the pediatric group and 9 patients in the adult group was missing; <sup>b</sup>Data of one patient in the pediatric group and 3 patients in the adult group was missing

**Table 2.** Operation related variables at the end of the follow-up period.

Variables	Pediatric group (age≤14) n=49				Adult group(age>14) n=57				p-value
	Mean±SD	Median	IQR		Mean±SD	Median	IQR		
			25	75			25	75	
			percentile	percentile			percentile	percentile	
Hospital stay (days) <sup>a</sup>	12.25±9.1	10.50	4	18	16±12.9	13	5	25	0.091
Scar score <sup>b</sup>	3.92±3.25	3	1	7	4.63±3.63	5	1	7.5	0.363
Graft take (%) <sup>c</sup>	92.38±8.3	95	90	100	93.6±7.1	95	90	100	0.461
Itch score	0.9±1.24	0.5	0	1	1±1.26	1	0	1	0.637

<sup>a</sup>Data of one patient in the pediatric group and five patients in the adult group was missing; <sup>b</sup>Data of one patient in the pediatric group was missing; <sup>c</sup>Data of two patient in the pediatric group and four patients in the adult group was missing

overall graft take, scar score, hospitalization time and itching score, these two groups were similar.

In a review in 2013 [12], Kapetanaki and colleagues concluded that as aging occurs, appropriate response to environmental injury decreases. In result of aging, the repair capacity is impaired and the extracellular matrix and interaction between cell and environment are altered.

Keylock *et al.* in 2008 [13] reported that older mice do not have an actual impairment regarding quality of healing, however similar to the previous studies, they do display delay in wound healing.

Every phase of the healing process undergoes age related changes including changes in platelet aggregation, increase in secretion of inflammatory mediators, delay in macrophages and lymphocytes infiltration, decrease in protein production (especially collagen), decrease in growth factor secretion and angiogenesis, decrease in wound integrity and delayed re-epithelialization [9, 14]. Blood flow of the skin decreases with aging making the skin more susceptible to burn injuries, furthermore the lymph drainage is impaired resulting in decreased pathogenic clearance and contraction of wound [9, 15].

In one study, 70 burn patients including 26 pediatric patients and 44 adults with 173 separate anatomic sites grafted, were followed for at least one year. Fifty-five percent of the grafted sites were excellent, 18% were good, 13% were fair and 14% were poor. The number of fair or poor results in pediatric patients (50%) was higher than adults (17%) [16]. In our study, there was no significant difference in percentage of graft take between children and adult burn patients.

Hypertrophic scar is an inevitable event that depends on burn depth. Post-burn scar invariably occurs in all deep burns (deep second degree and full thickness), due to long healing time of more than 3 weeks (an exaggerated wound healing response and excessive deposition of collagen) [17].

One of the most common complications of burn patients is itching. The beginning of this distressing sensation, is at the time of wound closure and peaks at 3 to 12 months or in a later time. In a survey in 2009, Forbes-Dochart *et al.*, [18] reported that 73.3% of patients complained from itching. In a

study by Young-Hee Choi *et al.*, [19], the mean itch score in 38 patients was 2.8, depending on tissue thickness. In a study by Carrouger *et al.*, [20], percentage of TBSA-burn and TBSA-grafted, were correlated to the severity of itching. They concluded that prevalence of burn-related pruritus was high, initially affecting >90% and persisting in >40% of long-term burn survivors. New predictors including younger age, dry skin and thick scars were identified for post-burn itching in the study. Considering the indifference in TBSA-burn percent and TBSA-grafted percent between the two age groups, no significant difference was found between the two groups regarding itching scores, in our study. For many years after the introduction of early excision and grafting, the use of this method for elderly patients was a controversial subject among authors. It was believed that elderly patients were not eligible candidates to withstand the stress of the surgery due to their fragility and predisposition to infections.

Our study has some limitations. We did not consider the cause of the initial burns, although in our adult population, the main cause of burn injury was fire and in our pediatric population, the main cause was hot liquids and this itself might have had a confounding effect on our results. Other limitations of the study include the wide age range in the adult group and the wide range of TBSA of burns (from 1% to 40%), furthermore this was a single center study. Long term cosmetic and functional evaluation was not done, which may have yielded better results for comparison. Due to the design of the study, blinding of patients and random allocation was not possible, which may have caused some bias. Another issue that may have caused different results between studies, relates to the definition of early excision and grafting used in literature. Some studies have defined early excision and grafting as less than seven days from the initial injury and a few have considered it as less than 12-13 days after the initial injury, especially in developing countries [3, 21, 22]. The ISBI Practice Guidelines for Burn Care in 2016 defined early excision and grafting as less than one week or in the most extreme conditions as less than 10 days of the initial injury [23]. Considering our patients' condition as they (many patients) do not refer for treatment during the golden time for receiving



early excision and grafting, furthermore our study was conducted before the publication of the ISBI Guidelines, we defined our inclusion criteria (within two weeks of injury) as “early” excision and grafting.

Studies with longer follow-ups including cosmetic and functional evaluation are needed for a more thorough evaluation of surgery related outcomes.

In conclusion, we found that age does not affect early excision and grafting clinical outcomes. Adults and elderly patients (14–65 years old) compared to pediatric patients (less than 14 years old) with less

than 40% TBSA burns, can expect similar results regarding scar score, graft take, itch score and hospital stay, after early excision and grafting (less than 14 days’ post-injury).

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**Conflicts of Interest:** None declared.

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