Early graft in patients with burn wounds: A two-year retrospective study of 582 patients at a referral burn center in northern Iran

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Abstract
Skin graft is the main treatment for burn wounds, which provides a favorable functional and aesthetic scar outcome. This study aimed to assess early graft in patients with burn wounds admitted to a referral burn center in northern Iran. This retrospective research was conducted on 582 patients with burn wounds with an early graft between May 2019 to 2021 at a referral burn center in northern Iran. Data gathering was conducted from May 2019 to 2021. A total of 582 patients with burn wounds with early graft were enrolled in this research. Of the patients, 91.41% were treated with one graft and 60.14% were treated with grafts less than 10% in size. The average graft/burn ratio in patients with burn wounds was 0.75 (SD=0.52). Also, 55.15% of patients with burn wounds had graft/burn ratio less than 0.75 (P=0.03). The mean length of stay in hospital in patients with burn wounds was 7.20 (SD=6.10). 61.34% of patients with burn wounds had stayed less than seven days in the hospital after early grafting. 4.12% of patients with burn wounds died due to early grafts (P<0.001). Although in the past decades, progress had been made in skin grafts for burns in Iran, however, prevention of complications and negative outcomes of burns and timely treatment of patients is still weak in Iran. Overall, the present study showed that patients with burn wounds with early grafts in Iran have had better clinical outcomes compared with low- and middle-income countries.

Keywords: Burns, Early Graft, Mortality, Burn Injury, Iran.
wound and cover the wound with autograft, allograft, or replacement with artificial skin [74]. Therefore, early graft leads to the preservation of the integrity of living tissues, prevents or controls infection, maintains shape and function, closes wounds in a timely manner, and reduces mortality [75]. In developed countries, an early graft is used as the standard treatment in patients with severe burns [72, 76, 77]. However, there are differences in the use of this procedure. For example, the optimal time for early burn removal and graft in previous studies vary from 24 hours to 6 days [75, 78-80]. This time may vary based on variables such as inadequate resources, inadequate primary resuscitation, and pre-existing malnutrition and anemia having inability to tolerate major surgery and blood loss in different countries [75]. A study in Iran (2017) showed that the most common cause of burns in burn patients with an early graft was hot liquids and their mortality rate was 4.8%. Also, they showed that age, inhalational damage, and burn grade were important predictors of mortality in burn patients with an early graft [3]. To our knowledge, there is limited epidemiological evidence in Iran that has described the epidemiological features and clinical outcomes of patients with burn wounds with early graft [3]. Therefore, the present study aimed to assess early graft in patients with burn wounds admitted to a referral burn center in northern Iran.

2 | Methods
2.1 | Study design and subjects
This retrospective research was conducted on 582 patients with burn wounds with an early graft between May 2019 to 2021 at a referral burn center in northern Iran. The present study was confirmed by the Ethics Committee of Guilan University of Medical Sciences (IR.GUMS.REC.1399.285).

2.2 | Inclusion and exclusion criteria
Acute burn patients with an early graft were included in all age groups. Medical records with incomplete information, patients who were hospitalized for more than 48 hours due to burns, patients who didn't have any graft within 7 days after the burn, and patients with grade I and II superficial burns were excluded from the present study.

2.3 | Data collection
Data were collected from medical records of patients with burn wounds with an early graft using a researcher-made checklist including age, gender, the primary cause of burns, burn’s grade, burn’s total body surface area (TBSA), number and size of grafts, graft/burn ratio, stay length in hospital, and in-hospital mortality.

2.4 | Statistical analysis
Data were analyzed using the SPSS software package (version 22.0, SPSS Inc., Chicago, IL, USA). Mean (standard deviation [SD]) and number (percentage) were used to present quantitative and qualitative variables, respectively. Based on the Kolmogorov-Smirnov test, data didn't have normal distribution. Chi-square test was used to assess the relationship between the study variables. Statistical significance was considered P<0.05.

3 | Results
3.1 | Individual characteristics and clinical features of participants
A total of 582 patients with burn wounds with early graft were enrolled in this research. The mean age of participants was 41.20 (SD=20.40) years. Of the patients with burn wounds with early graft, 67.53% were male, 58.76% had flame burns, 65.46% had grade III burn, and 69.07% had TBSA less than 20% (Table 1). Of the patients with burn wounds with early graft, 91.41% were treated with one graft, and 60.14% were treated with grafts less than 10% in size. The average graft/burn ratio in patients with burn wounds was 0.75 (SD=0.52). Also, 55.15% of patients with burn wounds had Graft/burn ratio less than 0.75 (P=0.03) (Table 2).

3.2 | Graft characteristics of patients with burn wounds with early graft
Of the patients with burn wounds with early graft, 91.41% were treated with one graft, and 60.14% were treated with grafts less than 10% in size. The average graft/burn ratio in patients with burn wounds was 0.75 (SD=0.52). Also, 55.15% of patients with burn wounds had Graft/burn ratio less than 0.75 (P=0.03) (Table 2).

3.3 | Clinical outcomes of early graft in patients with burn wounds
As presented in Table 2, the mean length of stay in hospital in patients with burn wounds was 7.20 (SD=6.10). Also, 61.34% of patients with burn wounds had stayed less than seven days in the hospital after early grafting. Finally, 4.12% of patients with burn wounds died due to early grafts (P<0.001).

4 | Discussion
The findings of the present research showed that the most common primary cause of burn in participants was flame (58.76%). Also, 91.41% of patients were treated using one graft and 60.14% of patients were treated by grafts less than 10% in size. The mean length of stay in hospital in patients with burn wounds was 7.20 (SD=6.10). Also, 61.34% of patients with burn wounds had stayed less than seven days in the hospital after early grafting. Finally, 4.12% of patients with burn wounds died due to early grafts.
Table 1. Individual characteristics and clinical features of patients with burn wounds with early graft (n=582).

<table>
<thead>
<tr>
<th>Individual characteristics</th>
<th>Participants (n=582)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (y)</strong></td>
<td>41.20 (SD=20.40)</td>
<td></td>
</tr>
<tr>
<td>&lt; 20</td>
<td>85 (14.61)</td>
<td></td>
</tr>
<tr>
<td>20-49</td>
<td>303 (52.06)</td>
<td>0.392</td>
</tr>
<tr>
<td>50-69</td>
<td>139 (23.88)</td>
<td></td>
</tr>
<tr>
<td>&gt;70</td>
<td>55 (9.45)</td>
<td></td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>393 (67.53)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>189 (32.47)</td>
<td>0.521</td>
</tr>
<tr>
<td><strong>Clinical features</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Primary cause of burns</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flame</td>
<td>342 (58.76)</td>
<td></td>
</tr>
<tr>
<td>Scalp</td>
<td>178 (30.59)</td>
<td></td>
</tr>
<tr>
<td>Chemical</td>
<td>19 (3.26)</td>
<td>0.043</td>
</tr>
<tr>
<td>Contact</td>
<td>25 (4.30)</td>
<td></td>
</tr>
<tr>
<td>Electrical</td>
<td>18 (3.09)</td>
<td></td>
</tr>
<tr>
<td><strong>Burns grade</strong></td>
<td></td>
<td>0.879</td>
</tr>
<tr>
<td>II &amp; III</td>
<td>93 (15.98)</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>381 (65.46)</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>108 (18.56)</td>
<td></td>
</tr>
<tr>
<td><strong>TBSA of the burn (%)</strong></td>
<td></td>
<td>0.003</td>
</tr>
<tr>
<td>1-20</td>
<td>402 (69.07)</td>
<td></td>
</tr>
<tr>
<td>21-40</td>
<td>139 (23.88)</td>
<td></td>
</tr>
<tr>
<td>41-60</td>
<td>33 (5.67)</td>
<td></td>
</tr>
<tr>
<td>61-80</td>
<td>8 (1.38)</td>
<td></td>
</tr>
<tr>
<td>81-100</td>
<td>0 (0)</td>
<td></td>
</tr>
</tbody>
</table>

SD: Standard Deviation.  
Data are presented as number (percentage) and mean (standard deviation).  
P-value was obtained with Chi-square test.

Table 2. Graft characteristics and clinical outcomes of patients with burn wounds with early graft (n=582).

<table>
<thead>
<tr>
<th>Participants (n=582)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of grafts</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>532 (91.41)</td>
</tr>
<tr>
<td>2</td>
<td>37 (6.36)</td>
</tr>
<tr>
<td>3</td>
<td>7 (1.20)</td>
</tr>
<tr>
<td>4</td>
<td>3 (0.52)</td>
</tr>
<tr>
<td>5</td>
<td>2 (0.34)</td>
</tr>
<tr>
<td>6</td>
<td>1 (0.17)</td>
</tr>
<tr>
<td><strong>Size of grafts (%)</strong></td>
<td></td>
</tr>
<tr>
<td>1-10</td>
<td>350 (60.14)</td>
</tr>
<tr>
<td>11-20</td>
<td>145 (24.91)</td>
</tr>
<tr>
<td>21-30</td>
<td>64 (11.00)</td>
</tr>
<tr>
<td>&gt;30</td>
<td>23 (3.95)</td>
</tr>
<tr>
<td><strong>Graft/burn ratio</strong></td>
<td>0.75 (SD=0.52)</td>
</tr>
<tr>
<td>&lt;0.75</td>
<td>321 (55.15)</td>
</tr>
<tr>
<td>≥0.75</td>
<td>261 (44.85)</td>
</tr>
<tr>
<td><strong>Clinical outcomes</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Length of stay in hospital (day)</strong></td>
<td>7.20 (SD=6.10)</td>
</tr>
<tr>
<td>&lt;7</td>
<td>357 (61.34)</td>
</tr>
<tr>
<td>≥7</td>
<td>225 (38.66)</td>
</tr>
<tr>
<td><strong>Mortality in-hospital</strong></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>24 (4.12)</td>
</tr>
<tr>
<td>No</td>
<td>558 (95.88)</td>
</tr>
</tbody>
</table>

SD: Standard Deviation.  
Data are presented as number (percentage) and mean (standard deviation).  
P-value was obtained with Chi-square test.

As presented in the present study, the most common cause of burns was flame. This finding was supported by a study in Egypt [81]. In contrast, the results of a study in Iran [3] showed that the most common cause of burns is hot liquids. This discrepancy may be due to differences in age, sex, occupation, and climatic conditions [82, 83]. For example, the most common cause of
burns in Nepali children was flame due to children’s curiosity at home and kitchen [82].

As presented in this study, of the patients with burn wounds with early graft, 65.46% had a grade III burn, 69.07% had TBSA less than 20%, 91.41% were treated with one graft, and 60.14% were treated with grafts less than 10% in size. Consistent with the present study, studies from South Africa [84] and China [85] showed that the majority of patients had TBSA less than 20%. However, the true proportion of minor to moderate burns in patients with burn wounds can be higher, as many minor burns are diagnosed and treated in outpatient wards. Obviously, this group has the lowest mortality rate compared with severe burns’ groups. However, improving life standards in patients with burn wounds after discharge is still an important challenge [86, 87]. Therefore, it is necessary to pay more attention to physiological and aesthetic aspects of patients with burn wounds, especially severe burns.

In the present study, the mean length of stay in hospital in patients with burn wounds was 7.20 (SD=6.10). Also, 61.34% of patients with burn wounds had stayed less than seven days in the hospital after early grafting. The length of stay in hospital in patients with burn wounds depends on several factors including age, higher TBSA, comorbidities, and respiratory injuries in patients [87-89]. Also, the results of a retrospective cohort study in Canadian patients with burn wounds [88] showed that factors such as number of days connected with mechanical ventilation and in-hospital complications like bacteremia, pneumonia, sepsis, graft loss, and respiratory failure have been significantly associated with longer expected hospital stays in patients with burn wounds.

In the present study, 4.12% of patients with burn wounds died due to early grafts. However, mortality rates in low- and middle-income countries after early grafts have been unclear. In poor populations in Africa, early grafting increases the risk of death in patients with burn wounds [75]. In contrast, the results of a study in India showed that early graft has reduced mortality rate [90]. However, mortality-related factors such as comorbidities, severity and TBSA of burns, and previous malnutrition in patients with burn wounds cannot be ignored [91]. Therefore, the present study showed that the mortality situation after early grafting in patients with burn wounds in Iran is more favorable compared with low- and middle-income countries (4.12% vs. 14.5%) [91].

4.1 | Limitations
To avoid bias selection, all medical records were evaluated over a specified period of time, and finally, subjects were selected based on predetermined inclusion and exclusion criteria. In addition, the researchers extracted the information completely and accurately and removed the missing data. This study was performed in a referral burn center in the north of Iran. However, some patients visit other treatment centers. Many patients may be transferred to other centers due to different treatment needs. Therefore, complete information was not available to all patients, which reduces the generalizability of the present study.

5 | Conclusions
Although in the past decades, progress had been made in skin grafts for burns in Iran, however, prevention of complications and negative outcomes of burns and timely treatment of patients is still weak in Iran. This research described the epidemiological features of patients with burn wounds with early grafts in the north of Iran. Overall, the present study showed that patients with burn wounds with early grafts in Iran have had better clinical outcomes compared with low- and middle-income countries.

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Authors’ contributions
Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work: MM, MT, ADM, EHR, NZ, RJ, MJG, PGV, SK; Drafting the work or revising it critically for important intellectual content: MM, MT, ADM, EHR, NZ, RJ, MJG, PGV, SK; Final approval of the version to be published: MM, MT, ADM, EHR, NZ, RJ, MJG, PGV, SK; Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved: MM, MT, ADM, EHR, NZ, RJ, MJG, PGV, SK.

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Ethics approval and consent to participate
The research was approved by the ethics committee of Guilan University of Medical Sciences, Iran (IR.GUMS.REC.1399.285).

Competing interests
We do not have potential conflicts of interest with respect to the research, authorship, and publication of this article.
Availability of data and materials
The datasets used during the current study are available from the corresponding author on request.

Using artificial intelligent chatbots
None.

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