ORIGINAL ARTICLE

Evaluation of the impact of donor site size on treatment outcomes in experimental deep second-degree burns treated with non-cultured autologous cell spray

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ABSTRACT

BACKGROUND: Deep second-degree burn treatment is often time-consuming and expensive, with split-thickness autografts being the current standard of care. Recently, noncultured autologous cell sprays have shown comparable efficacy. This study utilized an experimental animal model to determine the optimal donor-to-burn area ratio for this method.

METHODS: Twenty-four male Wistar-albino rats were assigned to three groups (A, B, and C), each receiving two standardized second-degree burn wounds (2 cm^2) on the dorsal skin. On day 5 post-injury, treatments were applied as follows: Group A wounds were left untreated or underwent tangential excision; Group B received autologous cell spray from 2 cm^2 and 1 cm^2 donor sites; Group C received cell spray from 0.5 cm^2 and 0.25 cm^2 donor sites. On day 14, all animals were sacrificed. Wound healing was assessed macroscopically (necrosis percentage) and histopathologically (ulcer size and inflammation score, 0–3).

RESULTS: Necrotic area percentage in the first and second burn site of the groups A, B, and C were 15±0.15%, 13±0.1%, 6±0.05%, 6±0.05%, 17±0.15%, and 9±0.1% (mean±standard deviation [SD]), ulcer size was 1.5±2.0 mm, 0.8±1.6 mm, 0.4±0.7 mm, 0.1±0.4 mm 2.4±2.1 mm, and 1.3±1.7 mm (mean±SD), and the inflammatory response was 1.8±1.5, 1.5±1.2, 0.8±1.0, 0.5±1.1, 2.0±1.1, and 1.5±1.4 (mean±SD), respectively. All evaluated parameters were statistically significantly better in the second burn area of Group B compared to the untreated group (p=0.007, p=0.041, p=0.043).

CONCLUSION: While previous research supports the use of small donor sites for extensive burns, our findings suggest that, in smaller burn injuries, a donor-to-burn area ratio of 1:2 provides more effective wound healing than further donor site reduction. The 14-day follow-up and reliance on a single thermal burn model limit the generalizability of these results. Future studies with extended observation, varied burn etiologies, and molecular or immunohistochemical analyses are needed to validate and expand upon these findings.

Keywords: Autologous cell spray; keratinocyte suspension; noncultured cell spray.

INTRODUCTION

Burns are defined as traumatic injuries to the skin or other organic tissues resulting from acute destruction caused by heat, cold, electricity, radiation, or caustic chemicals. The severity of the burn is one of the primary factors determining the treatment approach.[1]

The standard treatment for deep burn wounds typically involves excising the burned tissue and covering the area with either full-thickness or split-thickness autologous skin grafts.[2,3] However, in cases of major burns affecting a large area of the body surface, the limited availability of donor sites, coupled with complications like infection or unsatisfactory cosmetic

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results at these sites, can lead to prolonged hospitalization, increased treatment costs, and reduced patient satisfaction.[4] While cultured epidermal cells have been used in burn treatment for a while, several disadvantages such as the prolonged treatment period due to the required culture time, the loss of progenitor cells and epidermal stem cells during the in vitro culture process, and the subsequent premature differentiation of these cells have led to ongoing efforts to develop alternative treatment approaches.[5]

The introduction of the noncultured autologous cell spray technique has eliminated the need for a culture period. Furthermore, since this method does not involve in vitro cell culture processes, it provides significant advantages over cultured epidermal autografts by reducing both treatment time and overall costs.[6] These advantages have led to the growing popularity of the noncultured epidermal autograft technique in treating deep burns. Several studies in the literature have demonstrated that minimizing the ratio between the donor site area and the treated area can yield both functionally and cosmetically acceptable outcomes.[7,8] Further reduction of the donor site required for harvesting autologous graft cells would allow larger burn areas to be treated with grafts obtained from smaller donor sites, thereby enhancing the advantages of this technique. Such an approach would minimize donor site complications, lower treatment costs and hospitalization time, and ultimately improve patient satisfaction.

A review of the literature reveals that the autologous cell grafting method is highly effective in the treatment of burns; however, no comparative studies have been conducted regarding the optimal size of the donor area required for the preparation of autologous cells. This study aimed to determine the optimal donor site size using an experimental model involving noncultured autologous cell grafting.

MATERIALS AND METHODS

The study protocol was reviewed and approved by the Hacettepe University Animal Experiments Local Ethics Committee on February 23, 2021 (Project No: 2021/02. Approval No: 2021/02–07). All experimental procedures were carried out at the Hacettepe University Experimental Animals Application and Research Center, following institutional guidelines, the European Union Directive 2010/63/EU on the protection of animals used for scientific purposes, and the ethical principles outlined in the Declaration of Helsinki.

In this study, a total of 24 male Wistar albino rats weighing between 250 and 350 grams were used. The animals were randomly divided into three groups labeled A, B, and C, with eight rats in each group. Following recommendations from prior experimental burn model studies, the dorsal region of the animals was selected as the burn site to prevent them from accessing the wound area, thereby minimizing the risk of additional injury caused by scratching or biting the wound. Furthermore, the dorsal skin exhibits less contraction compared to other body regions, providing a more stable wound model.[9]

Two burn areas, each measuring 2 cm^2, were created on the dorsal skin of each rat. Consequently, six burn area subgroups were established to receive different treatment protocols (Fig. 1).

In group A, no treatment was applied to the first burn area (group 1), while only debridement was performed on the second burn area (group 2). In Group B, the first burn area (group 3) was treated with a cell spray prepared from a 2 cm^2 donor site, and the second burn area (group 4) received a cell spray obtained from a 1 cm^2 donor site. In Group C, the first burn area (group 5) received a cell spray derived from a 0.5 cm^2 donor site, while the second burn area (group 6) was treated with a cell spray prepared from a 0.25 cm^2 donor site. Accordingly, the donor-to-treated burn area ratios were 1:1 in group 3, 1:2 in group 4, 1:4 in group 5, and 1:8 in Group 6. The distribution of rats across the groups is summarized in Figure 1.

The animals were housed individually in separate cages for a 10-day acclimatization period before the experiment, with free access to water and standard chow. They were maintained under controlled environmental conditions at a constant temperature with a 12-h light/12-h dark cycle.

Before the experimental procedures, anesthesia was induced in the rats by intraperitoneal administration of a mixture of 90 mg/kg ketamine hydrochloride (Ketalar®, Eczacıbaşı, Istanbul, Turkey) and 10 mg/kg xylazine HCl (Alfazyne® 2%, 20 mg/mL, 30 mL, Alfasan Int B.V., The Netherlands). In accordance with the animal model described by Tavares Pereira et al.[10] for inducing second-degree burns, a 51-g aluminum plate with a surface area of 2 cm^2 was immersed in water heated to 100°C under thermometer control and maintained in the water until the temperature returned to 100°C. After shaving the dorsal skin, two deep second-degree burn wounds, each measuring 2 cm^2, were induced on the dorsal area of anesthetized rats by applying the heated plate, using its weight, for 15 s. Immediately after burn induction, analgesia was provided through subcutaneous administration of 40 mg/kg metamizole sodium (Onpyron®, Onfarma, Samsun) into the dorsal neck region, followed by oral administration of 200 mg/kg metamizole sodium mixed into the drinking water. In addition, to ensure hydration, 5 mL of physiological saline was injected subcutaneously into the dorsal neck area.[10]

Five days after burn induction, the animals were re-anesthetized for debridement and application of autologous cell spray. Anesthesia was achieved through intraperitoneal administration of a mixture of 90 mg/kg ketamine hydrochloride (Ketalar®, Eczacıbaşı, Istanbul, Turkey) and 10 mg/kg xylazine HCl (Alfazyne® 2%, 20 mg/mL, 30 mL, Alfasan Int B.V., The Netherlands).

In group A, no treatment was applied to the first burn area (group 1). The second burn area (group 2) was disinfected

using chlorhexidine (Dermanios Scrub®, Anios) and then underwent debridement through tangential excision with a handheld dermatome (Wecprep™ Blades, Pilling Weck Surgical, PA, USA).

Based on the recommendations of the studies conducted by Zhai et al.,[11] the right inguinal region of the subjects was used as the donor site for skin graft harvesting. Following appropriate anesthesia, the donor sites of the animals in Groups B and C were disinfected with chlorhexidine (Dermanios Scrub®, Anios). Two healthy skin grafts were harvested from each donor site using a scalpel. In Group B, skin grafts measuring 2 cm^2 (for group 3) and 1 cm^2 (for group 4) were obtained from each animal. In Group C, skin grafts measuring 0.5 cm^2 (for group 5) and 0.25 cm^2 (for group 6) were harvested from each animal. The skin grafts harvested from the animals in groups B and C were placed into sterile containers and cut into small pieces. The specimens were then incubated in prewarmed dispase II solution (Dispase II Neutral Protease, NC, USA) at 37°C for 40 min until the separation of the dermis-epidermis junction was achieved.

Subsequently, the tissue samples were transferred into Ringer's lactate solution to remove residual enzyme. The epidermis and dermis were mechanically separated using a scalpel and forceps in a separate sterile container. The isolated epidermis was then placed into a tube containing Trypsin/ ethylenediaminetetraacetic acid (EDTA) solution (Trypsin EDTA Solution C 0.05%/0.02%, Biological Industries, USA) and incubated with intermittent agitation for 15 min. Following enzymatic digestion, the specimens were washed with Ringer's lactate solution to remove any remaining enzyme. The cell suspension, previously washed with Ringer's lactate solution, was filtered through a 70- µm cell strainer (70 µm Cell Strainer, Orange Scientific, Belgium). The resulting suspension, which contained regenerative basal keratinocytes, was then centrifuged at 200 g for 5 min after adding Ringer's lactate solution. Following centrifugation, the supernatant (Ringer's lactate) was carefully removed using a syringe, leaving the cell pellet at the bottom of the tube. Fresh Ringer's lactate solution was added to the pellet, resulting in the preparation of the noncultured cell spray containing regenerative basal keratinocytes.[7]

In Groups B and C, following disinfection of the burn areas with chlorhexidine (Dermanios Scrub®, Anios), tangential excision was performed using a handheld dermatome (Wecprep™ Blades, Pilling Weck Surgical, PA, USA). Noncultured cell suspensions obtained from donor sites measuring 2 cm^2 and 1 cm^2 (Group 3 and Group 4, respectively) in Group B, and 0.5 cm^2 and 0.25 cm^2 (Group 5 and Group 6, respectively) in Group C, were applied to the debrided wounds using a syringe with a 22 G black needle tip. The suspension was sprayed from approximately 5 cm to ensure uniform coverage of the wound surface. After the procedure, all animals were housed individually in separate cages. Routine wound care was continued postoperatively by dressing the burn areas with sterile gauze soaked in petrolatum.

On day 14 following treatment, all animals from the three groups were sacrificed under high-dose anesthesia. Biopsy samples were collected from both the burn areas and from healthy skin. After sacrifice, all animals were evaluated macroscopically through direct observation, and photographs were taken for documentation. In all groups, wound healing and the presence of necrotic areas were assessed using millimetric grid drawings. If more than half of a square showed signs of healing, it was scored as 1; if necrosis was present, it was scored as 0. Based on the total number of squares, the percentage of macroscopic wound healing was calculated. Excisional biopsy samples were collected parallel to the long axis of the burn areas. The specimens were fixed in formalin and embedded in paraffin blocks. Sections of 5 µm thickness were prepared and stained with hematoxylin and eosin. Histopathological evaluation was performed under a light microscope. Tissue samples were assessed semi-quantitatively for wound healing parameters, specifically for the presence of non-epithelialized areas and inflammation. Inflammation was scored histologically on a scale from 0 to 3. (Table 1).

Statistical Analysis

Intra-group and inter-group factors were identified using Generalized Estimating Equations modeling. The significance of changes in cross-sectional ulcer size, inflammation score, and macroscopic necrosis percentage was analyzed by comparing these variables to the untreated control group. In this model, ulcer size and necrosis percentage were treated as continuous variables, while the inflammation score was modeled as an ordinal variable. The correlation between necrosis percentage and ulcer size was evaluated using Spearman correlation analysis. A $p<0.05$ was considered statistically significant.

RESULTS

Macroscopic Evaluation

Evaluation of necrotic area percentage

When evaluating all experimental animals, macroscopic analysis of post-sacrifice photographs revealed that the percentage

Table 1. Acute inflammation scoring system

	0	1	2	3
Acute inflammation score	None	Scant	Moderate	Abundant

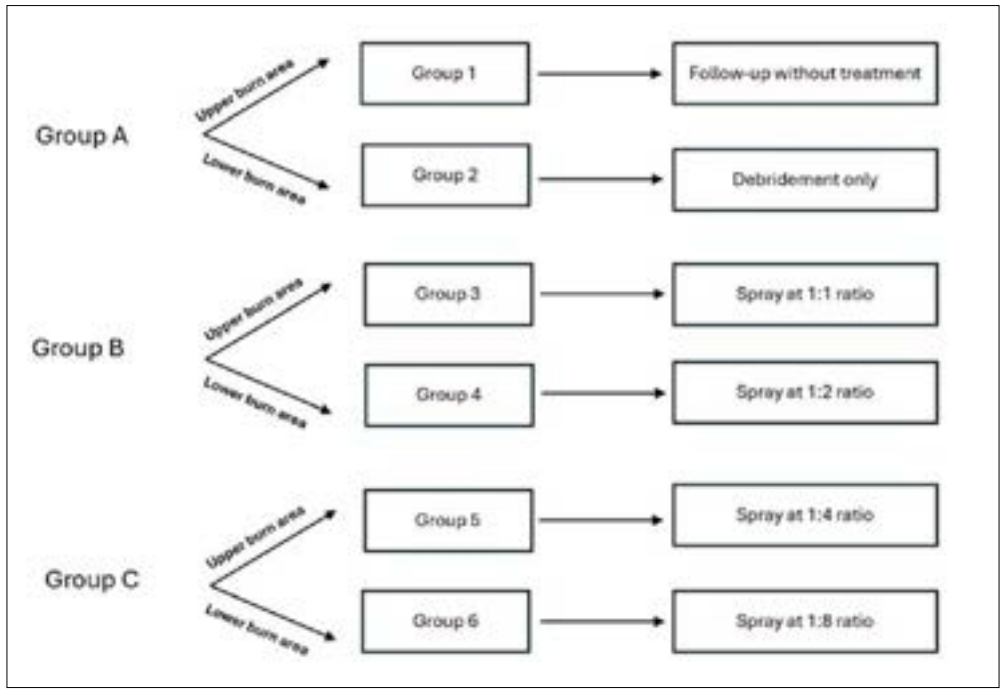

Figure 1. Allocation of rats across experimental groups.

of necrotic area (mean±standard deviation [SD]) within the burn sites was 14±0.11%, 6±0.6%, and 13±0.09% in groups A, B, and C, respectively. A more detailed group-wise assessment revealed necrotic area percentages (the mean±SD) of 15±0.15%, 13±0.1%, 6±0.05%, 6±0.05%, 17±0.15%, and 9±0.1% in the first (control), second, third, fourth, fifth, and sixth groups, respectively (p=0.43, p=0.035, p=0.007, p=0.70 and p=0.15). Each group was compared to the first control group. The box plot illustrating the percentage of necrotic area in experimental animal groups is given in Figure 2.

Histopathological Evaluation

Ulcer size

In the histopathological evaluation, the mean±SD ulcer size was 1.5±2.0 mm, 0.8±1.6 mm, 0.4±0.7 mm, 0.1±0.4 mm, 2.4±2.1 mm, and 1.3±1.7 mm in the first, second, third, fourth, and sixth groups, respectively (p=0.009, p=0.11, p=0.041, p=0.37, and p=0.77). Each group was compared to the first control group. Box plots illustrating ulcer size across experimental animal groups are given in Figure 3.

Inflammation score

When the subjects were assessed for inflammation, the mean±SD inflammation scores were 1.8±1.5, 1.5±1.2, 0.8±1.0, 0.5±1.1, 2.0±1.1, and 1.5±1.4 in the first, second, third, fourth, fifth, and sixth groups, respectively (p=0.97, p=0.10, p=0.043, p=0.66, p=0.25). Each group was compared to the first control group. Box plots illustrating inflammation

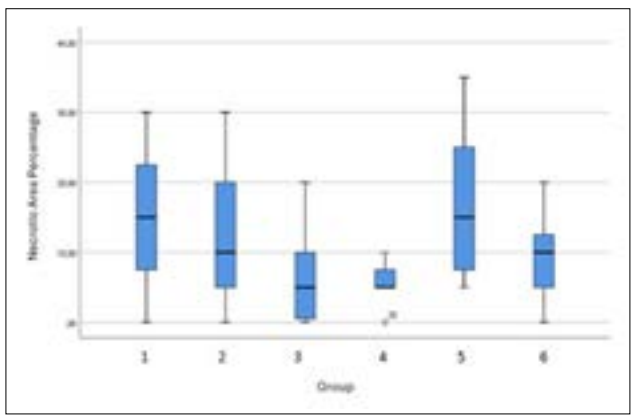

Figure 2. Box plot illustrating the percentage of necrotic area in experimental animal groups.

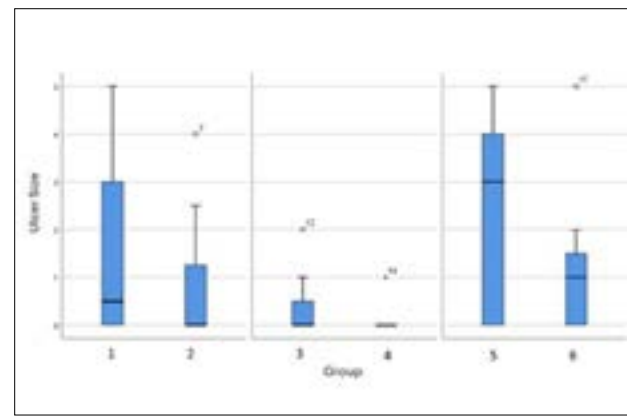

Figure 3. Box plot illustrating ulcer size across experimental animal groups.

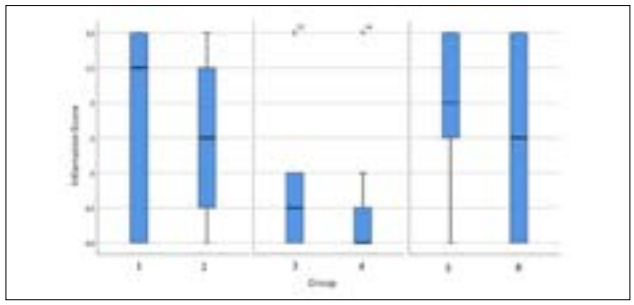

Figure 4. Box plot illustrating ınflammation scores across experimental animal groups.

scores across experimental animal groups are given in Figure 4.

The relationship between the percentage of macroscopic necrosis and ulcer size observed in histopathological evaluation was analyzed. Necrotic area percentages (mean±SD) were 15±0.15%, 13±0.1%, 6±0.05%, 6±0.05%, 17±0.15%, and 9±0.1% in the first (control), second, third, fourth, fifth, and sixth groups, respectively. The mean±SD ulcer sizes were 1.5±2.0 mm, 0.8±1.6 mm, 0.4±0.7 mm, 0.1±0.4 mm, 2.4±2.1 mm, and 1.3±1.7 mm for the first, second, third, fourth, fifth, and sixth groups, respectively. A statistically significant positive correlation was identified between the percentage of necrotic area and the size of non-epithelialized ulcers ($r=0.83$, $p<0.001$), as determined by Spearman correlation analysis.

DISCUSSION

Numerous studies and case series have employed varying donor-to-burn area ratios, yielding a range of outcomes. However, the direct impact of donor site size on wound healing has not been specifically investigated in these reports. In the present study, the most favorable macroscopic and microscopic results were observed in the group with a donor-to-burn area ratio of 1:2. A smaller donor site is inherently associated with improved cosmetic healing outcomes. Ratios ranging from 1:10 to 1:100 have been reported in the literature, accompanied by variable treatment results.[8,12,13]

Gerlach et al.[7] described a case series involving eight patients with deep second-degree burns who exhibited no signs of re-epithelialization after 14 days of conservative management. These patients were treated with a non-cultured autologous cell spray, using donor-to-treated area ratios ranging from 1:20 to 1:60. All patients achieved complete re-epithelialization within an average of 12–20 days, resulting in cosmetically acceptable outcomes. In our study, the follow-up period was limited to 14 days. It is plausible that a longer follow-up might have resulted in complete re-epithelialization in the animal models. Nonetheless, it is essential to note that prolonged epithelialization is generally considered undesirable, both from the patient's perspective and from the perspective of healthcare resource utilization. Gerlach et al.[7] did not assess the relationship between donor-to-burn area ratios and the rate or quality of treatment response. Moreover, histopathological evaluation was not conducted during the healing period to assess tissue regeneration across different donor-to-treated area ratios. Long-term complications such as hypo- or hyperpigmentation, hypertrophic scarring, and functional or cosmetic sequelae like contracture formation were evaluated at 6-month follow-up as treatment outcome. However, in our study, the experimental period was limited to 14 days; thus, long-term consequences were not assessed, as they fell beyond the scope of this investigation. Esteban-vives et al.[8] examined the therapeutic outcomes of non-cultured cell spray using donor-to-treated area ratios of 1:40–1:100 in six patients with burns of varying etiologies. Clinical assessments were performed between post-operative days 14 and 20, focusing on contracture development, hypertrophic scarring, and pigmentary alterations (i.e., hyperpigmentation or hypopigmentation). All patients exhibited rapid re-epithelialization, with both functional and aesthetic outcomes deemed satisfactory. No histopathological evaluation was performed, and the effect of different burn etiologies on treatment outcomes was not analyzed. In our experimental model, burn injuries were consistently induced using an aluminum bar, following the thermal contact burn protocol described by Tavares Pereira et al.[10] Consequently, only the therapeutic response to thermal contact burns was evaluated. Future studies should aim to compare the efficacy of non-cultured autologous cell therapies across various types of burn injuries to better understand the generalizability of this treatment modality.

In our study, the lowest mean inflammation score (0.5±1.1, $p=0.043$) was observed in Group 4, in which the donor-to-burn area ratio was 1:2. Burn wound healing proceeds through distinct and sequential phases: İnflammation, proliferation, and remodeling.[14] The inflammatory phase represents an essential immune response that initiates tissue repair and regeneration. However, excessive or prolonged inflammation may hinder this process, resulting in adverse outcomes such as increased fibrosis and scar formation.[15] Chronic, non-healing wounds are often characterized by persistent inflammation, which is recognized as a significant contributing factor to impaired wound healing.[16]

Recent studies have shown that the type and timing of immune cells present in the wound, and more importantly, the level of inflammation, are key indicators of whether the healing process is proceeding appropriately.[15] These observations support our findings, where improved outcomes were associated with a donor-to-burn area ratio of 1:2, in terms of both reduced inflammation and enhanced healing. In our study, groups with elevated levels of inflammation also exhibited a higher proportion of necrotic tissue relative to other groups. An increased percentage of necrotic tissue may be regarded as a macroscopic indicator of impaired wound healing. Considering that the evaluation was conducted on postoperative day 14, it can be inferred that wound healing was de-

layed in groups with higher inflammation and necrosis scores.

A statistically significant correlation was identified between the macroscopic percentage of necrosis and the ulcer area as determined by histopathological analysis. These findings suggest that macroscopic necrosis may serve as a reliable surrogate endpoint for evaluating treatment efficacy, potentially minimizing the need for time- and resource-intensive histopathological assessments. The lowest percentage of necrotic tissue was recorded in Group 4 (6±0.05%, p=0.007), which had a donor-to-treated area ratio of 1:2. This outcome indicates superior wound healing in this group. It suggests that a 1:2 ratio may offer an optimal balance between donor site limitations and therapeutic effectiveness.

On postoperative day 14, inadequate wound healing was observed both macroscopically and histopathologically in the group treated solely with tangential excision. This observation is consistent with existing literature, which indicates that tangential excision alone is insufficient for the effective management of deep second-degree burns.[17] Failure to achieve appropriate wound coverage following excision frequently leads to invasive infection or, at best, desiccation of the exposed wound surface. It is, in fact, widely acknowledged that performing excision without the capacity to ensure proper coverage may be more detrimental than leaving the eschar intact.

Based on the overall findings, the most favorable macroscopic and histopathological outcomes were achieved using the non-cultured autologous cell spray technique with a donor-to-burn area ratio of 1:2.

This study has several notable limitations. First, the follow-up period was limited to 14 days, which may have been insufficient to observe complete re-epithelialization or long-term healing outcomes. Extending the observation period could provide more comprehensive data on scar maturation, tissue remodeling, and functional recovery. Second, although the burn model employed—contact burns induced using an aluminum bar—is widely accepted in experimental research, it may not fully replicate the clinical characteristics and variability of scald or flame burns commonly encountered in patients. In addition, the absence of burn depth standardization due to uneven heat distribution may have introduced variability in injury severity, potentially affecting the consistency of results. Finally, the study focused exclusively on macroscopic and histological parameters, without incorporating molecular or immunohistochemical analyses, which could have offered more profound insights into the biological processes underlying wound healing.

CONCLUSION

While existing research suggests that smaller donor sites may be enough for treating extensive burns, our study results indicate that for smaller burn injuries, the best wound healing is more likely with a donor-to-burn area ratio of 1:2, rather than further reducing donor site size. In addition, the strong link between macroscopic necrosis and the ulcer area measured histopathologically supports using macroscopic necrosis as a practical marker for evaluating treatment response. The limited follow-up period of 14 days and the use of only a single thermal burn model limit how broadly these results can be applied. Future studies should include longer observation times, different burn causes, and molecular and immunohistochemical analyses to validate and build on these findings.

Ethics Committee Approval: This study was approved by the Hacettepe University Animal Experiments Local Ethics Committee (Date: 23.02.2021, Decision No: 2021/02–07).

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: S.T., A.K.; Design: S.T., K.K., A.K., Ö.C.; Supervision: A.K., Ö.C., S.T.; Resource: S.T., A.K.; Materials: S.T., A.K.; Data collection and/or processing: S.T., K.K.; Analysis and/or interpretation: S.T., B.K., K.K.; Literature review: A.K., Ö.C., S.T., B.K.; Writing: S.T., Ö.C., B.K.; Critical review: S.T., Ö.C., A.K.

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ORİJİNAL ÇALIŞMA - *ÖZ*

Kültüre-edilmemiş otolog hücre spreyi ile tedavi edilen derin ikinci derece yanıkların deneysel modelinde donör alanı büyüklüğünün tedavi sonuçlarına etkisinin değerlendirilmesi

AMAÇ: Derin ikinci derece yanıkların tedavisi genellikle zaman alıcı ve maliyetlidir; bu durumda, kısmi kalınlıkta deri greftleri halen standart tedavi yöntemidir. Son yıllarda, kültüre-edilmemiş otolog hücre spreyleri benzer etkinlik göstermeye başlamıştır. Bu çalışmada, bu yöntemin uygulanmasında en uygun donör alanı/yanık alanı oranını belirlemek amacıyla deneysel bir hayvan modeli kullanılmıştır.

GEREÇ VE YÖNTEM: Yirmi dört erkek Wistar-albino sıçan üç gruba (A, B ve C) ayrıldı ve her birinin sırt bölgesine standart boyutta (2 cm²) iki adet ikinci derece yanık oluşturuldu. Yanık sonrası 5. günde aşağıdaki tedaviler uygulandı: Grup A'da yaralar ya tedavisiz bırakıldı ya da tangensiyel eksizyon uygulandı; Grup B'de 2 cm² ve 1 cm² donör alanlarından elde edilen otolog hücre süspansiyonu uygulandı; Grup C'de ise 0.5 cm² ve 0.25 cm² donör alanlarından elde edilen hücre süspansiyonu uygulandı. Tüm hayvanlar 14. günde sakrifiye edildi. Yara iyileşmesi makroskopik olarak nekroz yüzdesi, histopatolojik olarak ise ülser boyutu ve inflamasyon skoru (0–3) ile değerlendirildi.

BULGULAR: Grup A, B ve C'nin birinci ve ikinci yanık alanlarında gözlenen ortalama nekrotik alan yüzdeleri sırasıyla %15±0.15, %13±0.1, %6±0.05, %6±0.05, %17±0.15 ve %9±0.1 idi. Ortalama ülser boyutları sırasıyla 1.5±2.0 mm, 0.8±1.6 mm, 0.4±0.7 mm, 0.1±0.4 mm, 2.4±2.1 mm ve 1.3±1.7 mm olarak ölçüldü. Enflamatuvar yanıt skorları ise sırasıyla 1.8±1.5, 1.5±1.2, 0.8±1.0, 0.5±1.1, 2.0±1.1 ve 1.5±1.4 idi. Grup B'nin ikinci yanık alanında değerlendirilen tüm parametrelerde, tedavisiz gruba kıyasla istatistiksel olarak anlamlı düzeyde daha iyi sonuçlar elde edildi (p=0.007, p=0.041, p=0.043).

SONUÇ: Önceki çalışmalar geniş yanıklar için küçük donör alanlarının yeterli olabileceğini öne sürerken, bu çalışmanın bulguları küçük yüzeyli yanıklarda donör/yanık alan oranının 1: 2 olarak belirlenmesinin yara iyileşmesini daha etkin şekilde desteklediğini göstermektedir. Ancak 14 günlük takip süresi ve yalnızca tek bir termal yanık modelinin kullanılması, sonuçların genellenebilirliğini sınırlamaktadır. Gelecekte daha uzun takip süreleri, farklı yanık etiyolojileri ve moleküler ya da immünohistokimyasal analizlerin yer aldığı çalışmalar ile bulguların doğrulanması ve genişletilmesi gerekmektedir.

Anahtar sözcükler: Keratinosit süspansiyonu; kültüre-edilmemiş hücre spreyi; otolog hücre spreyi.

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