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Comparison of Modified Meek Technique with Standard Mesh Method in Patients with Third Degree Burns

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A B S T R A C T

BACKGROUND: Severe burn injuries require prompt wound coverage to prevent complications such as infection, electrolyte imbalances, and organ failure. Skin grafting is a common approach, but limited donor sites pose challenges in extensive burns. The Meek technique offers high expansion capacity and is especially effective in poorly vascularized wounds. Most previous studies have been cross-sectional, with few directly comparing Meek and mesh grafts. This study aims to compare clinical outcomes of both techniques on different anatomical sites within the same patients.

METHODS: This case-control study enrolled patients with third-degree burns admitted to St. Fatima Hospital in Tehran. Each patient received both mesh and modified Meek grafts on different body areas following surgical debridement. Key outcomes including graft take, re-epithelialization time, hospital stay, and complications were recorded and analyzed using SPSS. Ethical approval and informed consent were obtained.

RESULTS: Among 20 patients with third-degree burns, the modified Meek technique showed significantly faster re-epithelialization (2.8 vs. 5.0 months, p=0.01), higher epithelialization within one month (55% vs. 15%, p=0.03), shorter operative time (p=0.036), and greater expansion ratio (p=0.04) compared to the mesh method. Graft rejection and infection rates were lower in the Meek group but not statistically significant.

CONCLUSION: The modified Meek technique resulted in faster re-epithelialization, shorter operative time, and greater expansion compared to the mesh method. These advantages support its use as a preferred grafting option in extensive burn cases.

Introduction

Each year, burn injuries are responsible for the deaths of over 300 million individuals worldwide(1, 2). In cases of third-degree burns also known as full-thickness burns all layers of the skin, including nerve endings, are destroyed(3). Deep burn wounds, particularly those covering a large body surface area, are commonly complicated by sepsis. The absence of skin increases the risk of dehydration and makes the body more susceptible to infections.

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Consequently, prompt wound coverage is a critical aspect of effective burn management. Severe electrolyte disturbances such as hyponatremia, hyperkalemia, metabolic acidosis, and even acute renal failure often develop in burn patients. However, early wound coverage can significantly reduce the likelihood of these complications(4-6). Dermal grafts are commonly applied in the management of both acute and chronic wounds(7). Grafts of intermediate or partial thickness include portions of both the epidermis and the dermis(8). Autologous grafts, also known as autografts, involve transplantation from one region of the patient's own body to another. Allogeneic grafts referred to as allografts or homograft's are obtained from genetically non-identical donors, whether living or deceased(9). In contrast, xenogeneic grafts (or heterograft's) originate from a different species, such as porcine sources(10, 11). Partial-thickness grafts require relatively minimal vascular support to reestablish skin integrity(8). Additionally, the dermal component in full-thickness grafts contributes to improved mechanical durability and enhances wound contraction, leading to superior cosmetic outcomes(12,13). In cases of burns affecting a larger Total Body Surface Area (TBSA), the limited availability of donor sites poses a significant challenge. To address this issue, a skin graft expansion technique was pioneered in 1958, which involved using small grafts or islands to cover a larger wound area. This method was further refined in 1964 with the introduction of graft meshing, which allowed for greater expansion of the graft. In 1993, the approach gained even more widespread use with the advent of the modified Meek technique, further enhancing the ability to cover extensive burn areas(14,15). Subsequent evaluations compared the efficacy of the Meek and mesh grafting techniques. Findings demonstrated that the Meek method allowed for a significantly higher expansion ratio up to 1:9 compared to the mesh technique, which achieved a maximum of 1:6. Importantly, the Meek system proved to be particularly suitable for managing extensive burn injuries, even in cases where the wound bed was suboptimal or covered with granulation tissue of poor quality(16).

A comprehensive clinical study conducted on 10 patients assessed the efficacy of the modified Meek micro grafting technique in the treatment of extensive burn injuries. The patients included in the study had burn wounds involving an average of 68% of their total body surface area. On average, each patient underwent approximately 2.2 surgical interventions. Graft take was successful in a majority of cases, and the mean time to complete wound closure was around 67 days. These findings highlighted the effectiveness of the Meek technique in achieving satisfactory wound coverage and favorable clinical outcomes, particularly in cases with limited donor site availability(17). Additionally, a systematic review published in 2018 analyzed 24 relevant studies focusing on the Meek technique. The review concluded that this micro grafting approach is particularly advantageous in wounds with poor vascularity, possibly due to the reduced metabolic needs of the small graft islands. This makes the method especially suitable for patients with underlying health conditions such as diabetes mellitus. Furthermore, it was demonstrated that the Meek technique is beneficial in severe burns, particularly those involving over 30% of the TBSA, and in situations where donor skin is limited, given its high expansion capacity. The only reported drawback was the characteristic dotted appearance of the grafted skin over time(14).

Although the majority of studies conducted on Meek micro-grafting have been cross-sectional in nature, there is a notable scarcity of clinical trials comparing the Meek and mesh techniques, particularly across different anatomical regions of the same individuals. By performing both techniques simultaneously on the same patients, potential biases related to host factors were minimized, allowing for a more definitive evaluation. Consequently, the objective of this study was to compare various outcomes, such as expansion rate, re-epithelialization, operation time, wound infection, graft failure, and other relevant factors, between the Meek and mesh techniques at different body sites of the same individuals.

MATERIALS AND METHODS

In this case-control investigation, all individuals presenting with third-degree burns to the referral burn unit at St. Fatima Hospital, affiliated with the School of Medicine at Iran University of Medical Sciences in Tehran, Iran, were enrolled. Upon admission, patients underwent initial resuscitation followed by surgical burn wound debridement, which was carried out either as a single procedure or in multiple sessions depending on the clinical need.

The debridement process employed a Humby knife to meticulously excise necrotic tissues until viable tissue characterized by punctate bleeding was reached. Hemostasis was maintained using gauze soaked in adrenaline, alongside appropriate dressings and continuous monitoring of both physical status and hemodynamic parameters. Exclusion criteria for this study included a history of smoking, burn injuries categorized as grade I, II, or IV, a confirmed diagnosis of diabetes or connective tissue disorders, and the presence of any clinically apparent wound infection. Additionally, individuals who declined participation or did not provide informed consent were not included. The research protocol received ethical approval from the Ethics

Committee of Iran University of Medical Sciences (IR.IUMS.FMD.REC.1398.281). All procedures adhered to the ethical principles outlined in the Declaration of Helsinki. Informed consent was obtained by the attending physicians, and all participants gave permission for their data and clinical images to be used for research and publication purposes. Furthermore, each patient received a detailed explanation regarding the extent of their burn injuries and the corresponding treatment plan.

Harvesting of the donor site was carried out using a dermatome blade, tailored to the dimensions and requirements of the skin graft. A portion of the harvested graft underwent meshing at ratios of 1:4 or 1:6, depending on the surface area needing coverage. These grafts were applied to the wound bed in one anatomical region and secured in place using surgical staples (Figure 1). Subsequently, the modified Meek technique was employed on the second limb or area. Initially, skin grafts were sectioned into 3×3 mm squares using the Meek mesher device (Humeca), producing small "postage stamp"–like fragments. Expansion ratios of 1:4 and 1:6 were utilized to accommodate the wound size. The individual graft islands were adhered to the recipient site using a specialized epidermal-side adhesive spray. A pleated polyamide dressing with an aluminum base was then applied over the grafts. The dressing plate was typically removed after five days, subject to the surgeon's clinical evaluation (Figure2). The data collected from patients, encompassing demographic factors (age, gender), the percentage of Total Body Surface Area (TBSA) involved, graft expansion ratios, length of hospital stay, graft rejection, development of contractures, hyperpigmentation, surgical duration, re-epithelialization time, and overall operation time, were meticulously recorded. These data were subsequently entered into SPSS software (SPSS Inc., Chicago, IL, USA) and analyzed statistically using Fisher's Exact and Mann-Whitney tests. A p-value of less than 0.05 was deemed statistically significant.

RESULTS

A total of 18 patients (90%) were male, while 2 patients (10%) were female. The mean age of the participants was 26.5±5.7 years, with an age range spanning from 19 to 54 years. This study included 20 patients (40 limbs or distinct areas) with third-degree burns who were eligible for skin grafting. The demographic characteristics of the patients are summarized in Table 1. Both the modified Meek technique and meshed grafting procedure were applied to all participants, and the outcomes were subsequently compared. The average Total Body Surface Area (TBSA) affected by burns was 36.9±16.6%. The mean body surface area covered by the Meek technique was 39%, while the mesh technique covered 30%. The incidence of graft rejection was 3 cases (15%) for the modified Meek technique and 5 cases (25%) for the mesh technique. However, the difference between the two was not statistically significant ($p>0.05$). Regarding wound epithelialization within the first month, 11 wounds (55%) in the Meek group and only 3 wounds (15%) in the mesh group achieved full epithelialization. This observed difference was found to be statistically significant ($p=0.03$, Figure 3). The mean re-epithelialization time for the Meek group was 2.8±2.5 months, whereas the mesh group exhibited a mean time of 5.0±2.1 months, with a statistically significant difference between the two groups ($p=0.01$, Figure 4).

Fig. 1. Meshed skin graft applied to the upper chest area.

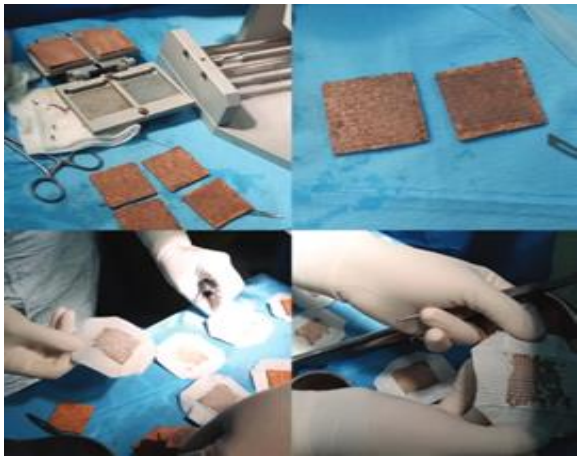

Fig. 2. Skin graft preparation using the modified Meek technique.

Table 1. Pre-treatment baseline profile of the study population

Variable	Value
Gender (M/F)	18/2 (90%)
Age (Mean±SD)	26.5±5.7
Mechanism of burn	
Scalds	8 (40%)
Flame	9 (45%)
Chemical	3 (15%)
Inhalation Injury	
Yes	2 (10%)
No	18 (90%)
TBSA burn	36.9±16.6
Hospital stay, Mean±SD (Days)	45.4±6.8 (21-135)

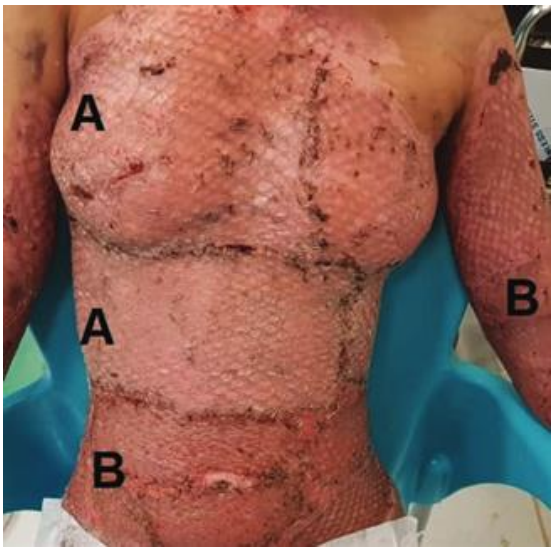

Fig. 3. A: Regions treated with mesh graft technique. B: Areas reconstructed using the modified Meek method, captured 18 days after surgery.

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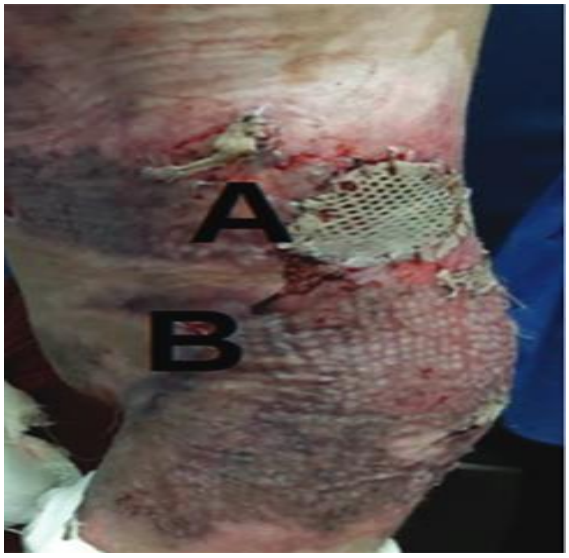

Fig. 4. *(A)* Sites managed with mesh grafting. *(B)* Regions treated using the modified Meek technique, documented 27 days following the surgical procedure.

The mean operative time for the modified Meek technique was 26.9±5.4 minutes, whereas the mesh grafting approach required an average of 32. ±7.4 minutes. The modified Meek technique demonstrated a significantly shorter operative time compared to the mesh method (p=0.036). The average expansion ratio achieved with the modified Meek technique was 5.7±1.9, exceeding the 4.2±1.8 ratio observed in the mesh graft method. The modified Meek technique exhibited a significantly higher expansion ratio compared to the mesh method (p=0.04). In the modified Meek group, 3 instances of local wound infection were documented, compared to 5 cases in the mesh group; however, this difference did not reach statistical significance. A comprehensive summary of the outcomes for both groups is presented in Table 2.

DISCUSSION

Management of patients with extensive burns focuses on maintaining homeostasis, preserving nitrogen balance, boosting immunity, and preventing infection, as accelerated wound healing directly contributes to an improved overall patient condition. Covering extensive burn wounds has long posed a significant challenge, prompting the development of various techniques and the use of both synthetic and processed skin products to achieve effective wound closure. These encompass biological dressings, amniotic membranes, and synthetic dressings, each accompanied by its own set of limitations(3). Autologous skin remains the optimal choice when available; consequently, the Meek technique was developed to achieve higher graft expansion rates.

Table 2. A summary of outcomes between the two groups

Variable	Meek	Mesh	*P* value
TBSA	44%	42%	>0.05
Graft rejection	3 (15%)	5 (25%)	>0.05
Mean time of re-epithelization. Mean±SD, month	2.8±2.5	5.0±2.1	0.01
Average duration of operation, minutes	26.9±5.4	32.1±7.4	0.04
Expansion ratio	5.7±1.9	4.2±1.8	0.04
Local wound infection	3 (15%)	5 (25%)	>0.05

TBSA: Table body surface area

Of forty pediatric patients with deep burns, those treated with the Meek technique showed a graft acceptance rate of 84.25%, which was significantly higher compared to mesh grafts (71.5%). Although the mean time for epithelialization was slightly shorter in the Meek group (27.1 days vs. 33.5 days), the difference was not statistically significant. Only 25% of Meek-treated cases developed wound infections, compared to 40% in the mesh group. The study demonstrated that Meek technique allowed for greater expansion and better scar outcomes (POSAS score 3.17 vs. 4.2), suggesting its effectiveness in extensive pediatric burns, despite a longer operative

time and learning curve(18). The results of this study were consistent with those of our investigation.

In an RCT conducted in China, 105 patients with grade III burns were divided into three groups: Meek, stamp, and micro skin. The Meek group showed higher graft survival, faster healing, and lower treatment costs compared to others(19). Cost comparison was not feasible since both techniques were applied to different limbs or anatomical areas within the same patients. Nevertheless, our findings also demonstrated a lower re-epithelialization rate with the Meek technique. This randomized controlled trial conducted in China compared the Meek and mesh skin grafting techniques in pediatric burn patients. The Meek method demonstrated a higher graft take rate (84.25% vs. 71.5%) and a shorter re-epithelialization period (27.1 vs. 33.5 days). Additionally, scar quality was rated superior in the Meek group. The infection rate was lower in the Meek cohort (25% vs. 40%). Despite requiring greater technical expertise, the Meek technique was found to be more cost-effective overall(18). In 2020, the Meek technique was evaluated in a case-control study involving 20 patients with third-degree burns. Each patient received both Meek and mesh grafts on different body areas. The Meek technique resulted in a significantly shorter operative time (26.9 min vs. 32.1 min; p=0.04), faster re-epithelialization (2.8 months vs. 5.0 months; p=0.01), and higher expansion ratio (5.7 vs. 4.2; p=0.04), suggesting superior performance in wound coverage with limited donor sites(20). The findings of this study were also consistent with our results. A randomized controlled trial (RCT) conducted in 1994 compared the Meek micro grafting technique with traditional meshed skin grafting in patients with extensive burn injuries. The study demonstrated that the Meek technique achieved an expansion ratio of 1:9, significantly higher than the 1:6 ratio obtained with meshed grafts. This higher expansion ratio allowed for more efficient coverage of large burn areas, making the Meek technique a practical alternative when donor sites are limited. Additionally, the Meek technique resulted in better graft take rates and faster re-epithelialization compared to meshed(16). These results are consistent with our findings, as we also demonstrated a significantly greater expansion ratio using the modified Meek technique compared to the mesh graft method. In 2016, ten patients with an average total body surface area burn of 68±9.2% underwent the Meek procedure. Although all patients developed visible wound infections, the mean area requiring re-grafting was limited to 13.1±6.4% TBSA(17). In contrast, our study reported local wound infections in only three cases within the Meek group, reflecting a significantly lower incidence. Additionally, graft failure rates in their study exceeded those observed in ours. Nevertheless, their commitment to routinely implementing the Meek technique in their center is commendable. Although numerous clinical trials have demonstrated the efficacy and potential superiority of the Meek technique over other grafting methods, there remains a notable lack of case-control studies directly comparing Meek and mesh grafting particularly those conducted on different anatomical sites within the same patient. A key strength of our study lies in its relatively large sample size compared to similar investigations, coupled with a case-control design in which both grafting techniques were applied simultaneously to different limbs or anatomical areas of the same patients. This within-subject approach minimized bias related to individual host factors and enabled a more accurate and reliable comparison of outcomes. One of the main limitations of our study was the inability to compare patient survival rates or treatment costs between the two techniques, owing to the constraints of our study design. Additionally, patients with diabetes mellitus were excluded, limiting the generalizability of our findings. Future multicenter case-control studies with larger sample sizes particularly those including patients with underlying conditions such as diabetes are strongly recommended to provide a more comprehensive evaluation of the Meek technique. Furthermore, it is advisable for scientific burn societies to closely examine the outcomes of this method across various clinical trials and to consider developing preliminary guidelines that support its adoption as a standard approach for managing extensive burn injuries.

CONCLUSION

The Meek technique demonstrated a significantly shorter mean re-epithelialization time compared to the mesh method. Moreover, the modified Meek approach was associated with reduced operative time and higher patient satisfaction. Notably, the expansion ratio was significantly greater in the Meek group. Given these advantages, the Meek technique should be strongly considered as a routine grafting option, particularly for patients with extensive burn surface areas.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest related to this study.

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Authors' Contributions
All authors contributed to data analysis, drafting, and revising of the paper and agreed to be responsible for all the aspects of this work.

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