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Case Report

Application of Meek micro-grafting technique in severe burn injury: a case report

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ABSTRACT

Wound closure is often a challenge in patients with major burns due to the limited amount of healthy skin available for harvesting and grafting. As a result, this often yields severe morbidity and mortality amongst said patients. This case report presents the successful use of the Meek micro-grafting technique on a patient with extensive major deep dermal to full-thickness burn injuries in the Burn Unit of the Kuala Lumpur Hospital of Malaysia. The Meek micro-grafting method, involves the creation of micro-grafts from a small and limited donor site, and proved to be effective in promoting wound healing and minimizing donor site morbidity.

Keywords: Meek micrografting, Burn injuries, Wound healing, Skin grafts, Donor site morbidity

INTRODUCTION

Addressing traumatic skin loss, particularly in major burns, necessitates skin grafting for tissue restoration.[1-14] In cases of substantial burns with limited donor sites, an expanded skin graft may be required. Prompt wound closure significantly influences successful recovery, typically achieved through debridement and skin grafting.[14] Meek introduced micro-grafting, a technique involving the division of skin into smaller pieces, enabling up to a tenfold skin expansion. This technique has become a promising approach to enhance wound healing outcomes while minimizing donor site complications.[1] This case report aims to detail the application and outcomes of Meek micro-grafting in a patient treated in the Burn Unit of the Kuala Lumpur Hospital, Malaysia with major burn injuries. All necessary consents were granted by the patient.

CASE REPORT

Our patient is a 39 years old Indian housewife who was attempting to burn trash outside her house compound, when the fire, as a result of a gust of wind, engulfed her clothes in flames.

Despite promptly seeking treatment at the nearest hospital within an hour of injury and the initiation of fluid resuscitation via the Parkland regimen, she sustained a mixed-thickness flame injury of 50% of her total body surface area, involving all 4 of her limbs, her trunk (anteriorly and posteriorly), her chest and breasts. Following completion of fluid resuscitation and obtaining haemodynamic stability, she underwent numerous wound debridements and tangential excisions over the affected areas with the aim of reducing the micro-bacterial load and obtaining suitable wound beds for grafting.

However, as a result of limited donor sites, traditional grafting options were limited due to the extent and severity of the injuries. The decision was made to employ the Meek micro-grafting technique to address the challenging wound closure. Over the subsequent weeks following Meek micro-grafting, the patient exhibited remarkable improvement in wound healing. The Meek micro-grafting technique facilitated rapid epithelialization and reduced the risk of infection.

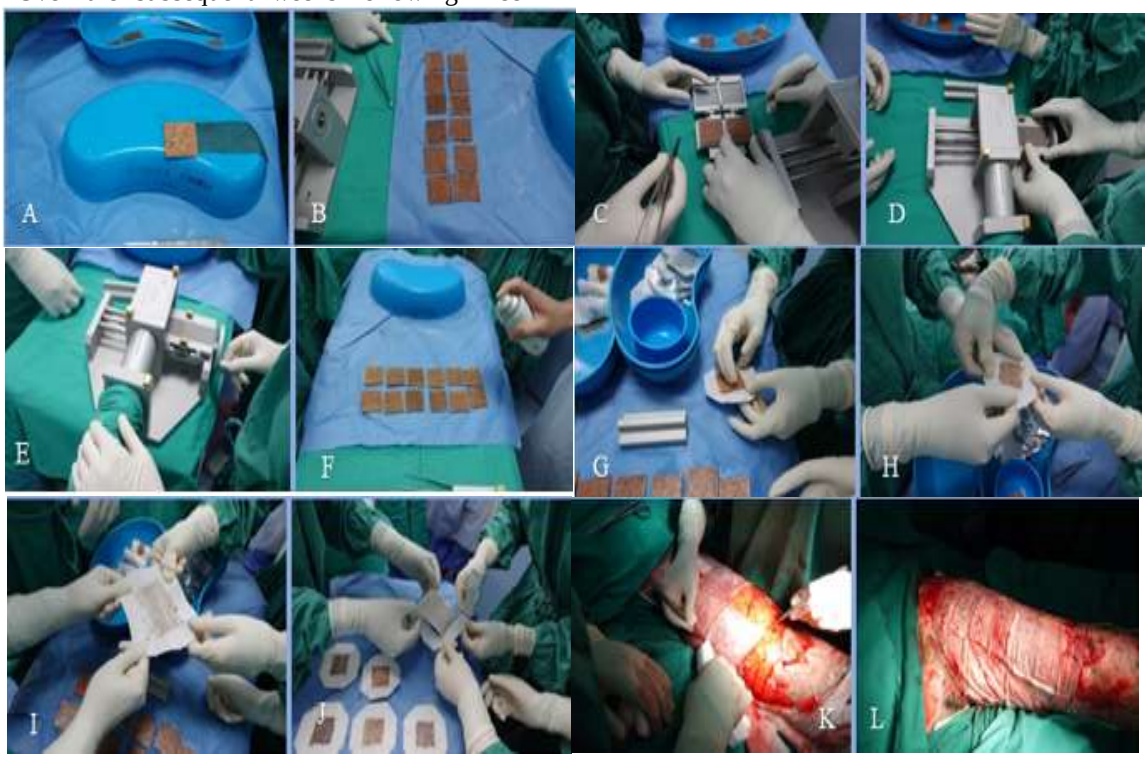

Figure 1: (A, B) The STSG is displayed with the dermal side on a cork square (42×42 mm); (C, D, E) the cork plate with the STSG is then passed through the Meek-wall dermatome machine, where the rotating blades cut through the graft, resulting in the STSG being cut into 14 stripes, each one 3 mm wide. After the first pass, the cork plate is rotated 90° and passed through the machine once more, cutting the STSG into 14×14=196 pieces of 3×3 mm; (F) the epidermal side of the sliced graft on the cork plates are then sprayed with an adhesive spray from a distance of 20 cm away and allowed to dry for about 5 min; (G) the cork-plates are then pressed, graft side down, onto the nylon side of a pre-folded gauze, ensuring the square of the cork plate corresponds with the square of the pleated area of the gauze; (H) just prior to transplantation, the cork plates are gently removed, leaving the grafts adhering to the gauze; (I) the gauze is pulled outwards by firm traction on all four sides, until the pleats become entirely unfolded. The expansion ratio is determined by the type of pre-folded gauze used, up to a ratio of 1:9; (J) the margins of the gauze are trimmed and the aluminium backing is peeled off, leaving the expanded gauze, with the separated autograft islands ready for transplantation; and (K, L) the gauze is applied, graft side down, to the wound bed and secured with surgical staples.

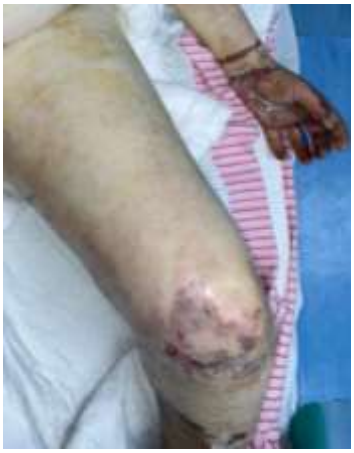

Figure 2: Left thigh wound upon admission.

The donor site, located on the contralateral thigh, demonstrated minimal morbidity, contributing to overall patient satisfaction. After one week following surgery, the wound was inspected, looking for signs of hematoma formation or infection. The nylon gauze removed, leaving the autograft islands in situ on the wound bed. The grafts were then covered with a non-adherent dressing to prevent any movement during daily dressing changes. After a further 5 days, a second inspection of the wound was done. Daily dressings were continued until re-epithelialisation was complete.

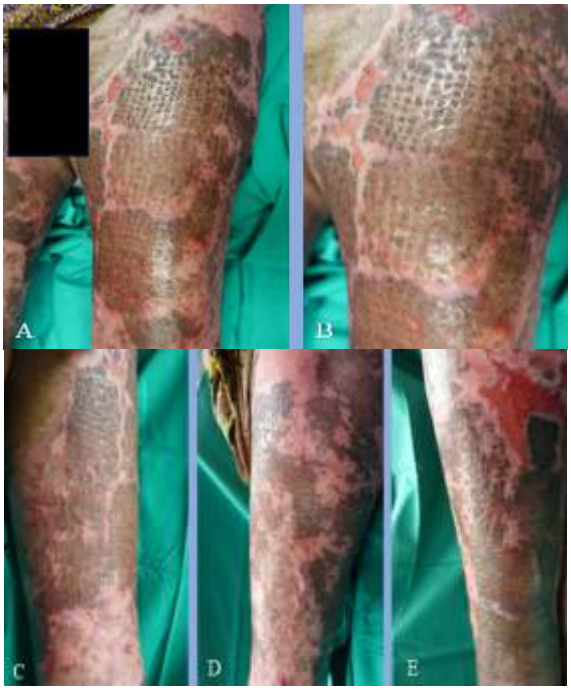

Figure 3: 1 month post tangential excision and Meek micro-grafting of right thigh- the classic 'Polka dots' appearance (A) anterior aspect of right thigh; (B) anterior aspect of right thigh (zoomed in); (C) medial aspect of right thigh; (D) lateral aspect of right thigh; and (E) posterior aspect of right thigh.

DISCUSSION

Meek micro-grafting, a technique employed for skin coverage in burn patients, has the potential to enhance outcomes. The initial documentation of this method dates back to a newspaper article on 13 December 1953, titled 'Forsyth native performs rare skin grafting'. The article highlighted Cicero Parker Meek, the pioneer of this technique. A graduate of the Medical College of Georgia, Augusta, US, Meek introduced the procedure in 1958, utilizing a micrograft, a partial-thickness skin expansion device, which preceded the mesh technique. The inaugural case involved a 14-year-old female with burns covering approximately 25% of her total body surface area (TBSA).[2]

Meek's original grafting device featured a 13-blade cutter powered by an electric motor. Initially, Meek used small skin islets saturated in plasma, manually transferring them to parachute silk, which was then transplanted onto the wound bed. His subsequent cases in 1958 further explored the efficacy of micro-dermagrafting. However, the method fell into obscurity with the advent of mesh skin grafts in 1964 by Tanner.[2] The modified Meek technique, introduced in 1993 by Kreis, enhanced the procedure with a special glue spray and modified nylon pleats, improving efficiency and acceptance. This method involves a square cork plate covered with a split-thickness skin graft (STSG), cut into 14×14 square pleats for grafting onto the wound bed.[2]

Comparatively, the mesh technique, described by Lanz in 1971, involved meshing STSG to achieve expansion. However, discrepancies between expected and actual expansion ratios, along with the need for suitable donor sites, led to renewed interest in the Meek technique in the 1990s.[2] A comprehensive review of the literature searched via Medline, and Pubmed, using terms such as 'micrograft', 'micrograft technique', 'Meek', 'Meek technique', 'major burn treatment' and 'mesh skin graft', identified multiple relevant studies supporting micrografting for major burns (>30% TBSA), particularly when donor site availability is limited. Said studies revealed significant advantages of the Meek technique over mesh grafts, including fewer surgeries, shorter hospital stays, and lower allograft usage. The Meek technique demonstrated successful re-epithelialization within specific timeframes. Despite some drawbacks, such as a 'polka dot' appearance during healing, micrografting excelled in treating poor wound beds, offering higher success rates compared to mesh grafts.[2-5]

With regards to physiology, the healing process in wounds containing micro-grafts is primarily guided by the proliferation and migration of keratinocytes. Initially, micro-grafts of a specific size (0.8×0.8 mm) rely on the diffusion of wound fluid rather than neovascularization for survival. This process is facilitated by the created environment. The micro-grafts demonstrate survival and proliferation irrespective of their orientation, contributing to the re-epithelialization of the wound.[2] Approximately 2 weeks post-operation, the number of vessels per surface area in the subepidermal plexus of transplanted micro-grafts is significantly increased ($p<0.005$) compared to control wounds.[2]

Untransplanted wounds exhibit a significantly lower number of rete ridges compared to normal skin ($p<0.01$). The number of rete ridges per linear mm, often used as an indicator of the dermal-epidermal junction's strength, is 7.6±1.8 in healthy normal pig skin 21 days after transplantation. There is no statistically significant difference between transplanted wounds (5.7±1.9 rete ridges/mm) and normal skin. Ungrafted wounds show a significantly lower number of rete ridges (4.7±1.6 rete ridges/mm) than normal skin ($p<0.01$).[9] On day 123, the number of rete ridges in the regenerated epithelium is 4.6±1.4 in micrograft-transplanted wounds and 4.2±1.9 in

untransplanted wounds, both significantly lower than normal skin. Micro-grafts exhibit a significantly reduced surface area compared to dry controls ($p<0.01$). On day 10, wounds treated with micro-grafts and moist dressings, micro-grafts and wound chambers, and dry controls are 71.5±10.5%, 60.0±13.0%, and 86.2±13.7% of the original wound surface area, respectively. Both micrograft-treated groups show a significantly reduced surface area compared to dry controls ($p<0.01$). On day 14, wounds covered with moist dressings, wound chambers, and dry controls are 58.4±8.6%, 51.1±10.7%, and 71.1±6.2%, respectively.[8,9] The rate of expansion is dependent on various factors associated with the quality of the skin graft and the recipient wound bed. When grafting extensive areas, it is crucial to accurately estimate the required donor site based on the chosen technique. For instance, planning an operation with a 1:3 ratio using a 310 cm^2 STSG can achieve coverage of up to 493 cm^2 with a mesh graft or 927 cm^2 with a micro-graft mesher. Notably, the Meek technique, boasting true expansion ratios from 1:3 to 1:9, necessitates only about half of the graft surface compared to the mesh graft method. This could lead to a potential overestimation of the true expansion rate by 55%, necessitating subsequent adjustments in the operative procedure when dealing with extensive surface areas. Micrografting, which allows for the utilization of small skin remnants, closely mirrors the true expansion rate by 86.5-99.8% when using expansion rates of 1:3 and above.[2-5]

In comparing the 'mesh' and 'Meek' groups, the 'Meek' group exhibited fewer surgeries, a shorter average hospital stay (51 days versus 120.5 days), and reduced allograft usage for each TBSA% burns (115.7 cm^2 versus 356.5 cm^2), resulting in overall lower patient costs. These statistically significant improvements exceed 50% ($p<0.05$). Complete re-epithelialization with the Meek procedure was observed within 7-10 days following the graft for a 1:4 ratio, 2-3 weeks for a 1:6 ratio, and one month for a 1:9 ratio.[7,13] Micro-grafting also exhibits a higher efficacy on compromised wound beds, characterized by infection and/or poor vascular supply, attributed to its low metabolic demands and a greater skin coverage expansion ratio of 1:12.[2,7] The assessment of re-epithelialization revealed that, by day 10, the surface of the grafted wounds had regenerated to 77.9±10.9%, a significant contrast to the 28.9±4.6% observed in ungrafted wounds ($p<0.005$). By day 14, the grafted wounds achieved complete epithelialization. In comparison, ungrafted wounds were 28.9±4.6% epithelialized on day 10, 49.1±11.4% on day 14, 87.1±7.1% on day 18, and fully healed by day 21, which is one week later than the transplanted wounds. The migration and proliferation processes of the grafted micro-grafts closely mirrored those observed in the healthy model.[12]

However, the Meek technique does have drawbacks, including a 'polka dot' appearance during healing, which is not observed with the mesh technique. Additionally, the initial surgeries involved in creating the micrograft squares are relatively labor-intensive (Figure 1).

CONCLUSION

The application of Meek micrografting in severe burn injuries demonstrates promising results in terms of wound healing and donor site preservation. The technique has showcased notable advantages. Micro-grafts, prepared from extremely small skin grafts, a feat unattainable with traditional mesh techniques, were a distinctive feature. This grants us the ability to cover large burn areas with a limited donor site. This case underscores the potential of Meek micrografting as a valuable tool in the management of extensive burn injuries. However, a drawback of the Meek technique lies in its greater economic demands. Further studies and larger case series are warranted to establish the broader efficacy and long-term outcomes of this technique in the field of burn care.

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