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Five years' experience of the modified Meek technique in the management of extensive burns

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ABSTRACT

Background: The Meek technique of skin expansion is useful for covering a large open wound with a small piece of skin graft, but requires a carefully followed protocol.
Methods: Over the past 5 years, a skin graft expansion technique following the Meek principle was used to treat 37 individuals who had sustained third degree burns involving more than 40% of the body surface. A scheme was devised whereby the body was divided into six areas, in order to clarify the optimal order of wound debridements and skin grafting procedures as well as the regimen of aftercare.
Results: The mean body surface involvement was 72.9% and the mean area of third degree burns was 41%. The average number of operations required was 1.84. There were four deaths among in this group of patients.
Conclusions: The Meek technique of skin expansion and the suggested protocol are together efficient and effective in covering an open wound, particularly where there is a paucity of skin graft donor sites.

1. Introduction

Early debridement of burns and coverage with autologous skin graft form the mainstay of burn management. However, this is often hindered by an inadequate supply of uninjured skin for grafting. In 1958, Meek described a technique for expanding a small piece of skin graft with a dermatome [1]. Although the technique was mechanically sound, surgeons failed to understand its advantages, probably because the tool involved was too cumbersome. In its place, a simpler method of expanding a piece of skin graft was described by Tanner in 1964 [2]. However, the effectiveness of the Tanner mesh skin graft technique also had impediments; re-epithelialisation, for instance, might be delayed or even absent when a meshed piece of skin was expanded beyond a ratio of 1:6.

In 1993, Kreis modified Meek's original technique by using a different device for skin cutting and by incorporating an aluminum foil backing to facilitate the expansion of tiny skin grafts [3]. This method, although remaining somewhat cumbersome, has been found effective in the treatment of extensive burns. Over the past 5 years, we had the opportunity to manage large areas of burn using this technique. Although the technical details of processing a skin graft have not changed, we have altered the regimen, i.e. the approach to skin graft handling, the order of graft application and the aftercare. The experience gained forms the basis of this report.

2. Materials and methods

2.1. Patients

Between 2000 and 2004, a total of 37 people underwent 68 skin grafting procedures involving the modified Meek micrografting

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Table 1 – Patient characteristics

Characteristic	Number (total 37)	Range	Mean
Age in years		8–80	34
Males	26		
Females	11		
% body surface burned		40–97	72.9
% body surface with third degree burns		10–90	41
Area grafted at each operation		8–25	13.8

technique for wound coverage. The Meek Micromesher (Humeca, Netherlands) was used to process the grafting materials. The mean age of the patients was 34 (8–80) years, and 26 were men. As shown in Table 1, mean body surface involvement was 72.9% (40%–97%), of which third degree involvement comprised 10%–90% (mean 41%).

2.2. *Management*

Cause of injury was quite variable, but fire was the most common (Table 2). Initial resuscitation followed the Parkland formula, although the clinical manifestations governed further use of the colloid solution. Decompression of limb compartments was carried out as necessary. The following scheme was formulated to facilitate subsequent surgical treatment.

2.2.1. *Topographical division of the body surface*

To determine the sequence of wound care, the body surface was divided into six regions: head and neck, anterior torso, posterior torso, right and left upper extremities, right lower extremity and left lower extremity.

2.2.2. *Initial surgical treatment*

Although wound excision began between the 2nd and 7th day after hospital admission, the procedure was repeated every 2–4 days providing the patient's condition allowed surgical intervention. The Weck knife and the Humby knife were the most commonly used tools for shaving the skin for grafting down to the layer grossly judged to be viable, i.e. to active punctuate bleeding. The entire skin down to the fascia was removed when indicated. Wounds in the lower extremity were treated first, followed by the upper extremity and the trunk. Wounds in the head and neck area were usually left until last. Each debridement procedure was completed within 1 h, and the amount of wound excision seldom exceeded 30% of the surface that had been burned. Blood volume was replenished as indicated. Meshed porcine skin was used to cover debrided wounds initially. In the interim, the patients continued to receive wound care and treatment for metabolic derangement.

Table 2 – Causes of burn

Cause	Number of cases
Flame	33
Chemical	3
Electrical	1

Fig. 1 – Markings are made in the graft donor site, i.e. the scalp in this case.

2.2.3. *Autologous skin grafting of the wound*

The patient was taken back to the operating theatre for autologous skin grafting procedures 1 or 2 weeks later, once metabolic abnormalities and wound sepsis were controlled.

The donor site, most commonly the scalp, and the wound were prepared in the usual manner in theatre. The extent of skin expansion required was determined by the size of the wound and the size of the available skin for grafting. Markings were made in the graft donor site (Fig. 1). A 2-in. blade was used to harvest the skin graft which was stretched over a wooden board, with its inner layer facing upward. A moistened cork plate was applied to the graft (Fig. 2) and the excess skin was trimmed. Fragments of skin graft smaller than 2 in. were placed together to form a segment that would fit the cork template carrier. Meshing of the graft was achieved by passing the carrier that housed the cork so that it was secured in a grille when passed through the cutting machine (Fig. 3). This device was equipped with 13 circular blades that cut the graft into 14 strips of skin each 3 mm in width. In order to fabricate 196 pieces of micro-sized skin graft, each measuring 3 mm × 3 mm, the carrier block containing the 14 strips of skin was rotated by 90° and then passed through the cutting machine again. The cut grafts were transferred to another carrier, made of polyamide gauze with aluminum foil backing, by removing the cork plate, the epidermal surface of

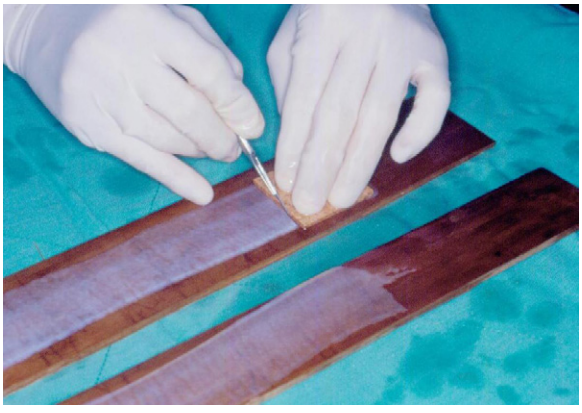

Fig. 2 – The graft is stretched over a wooden board with its inner layer facing upward, and a moistened cork plate is placed over the skin graft for cutting.

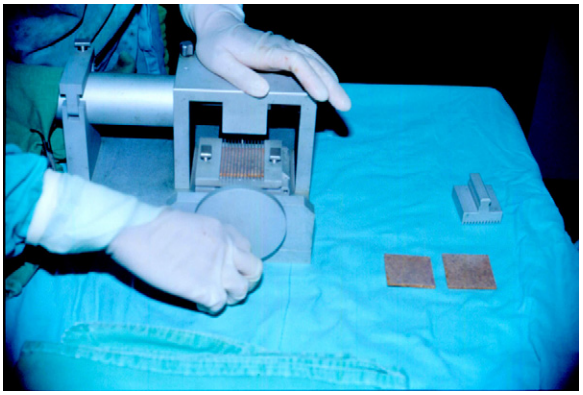

Fig. 3 – Meshing of the graft is achieved using the modified Meek–Wall dermatome.

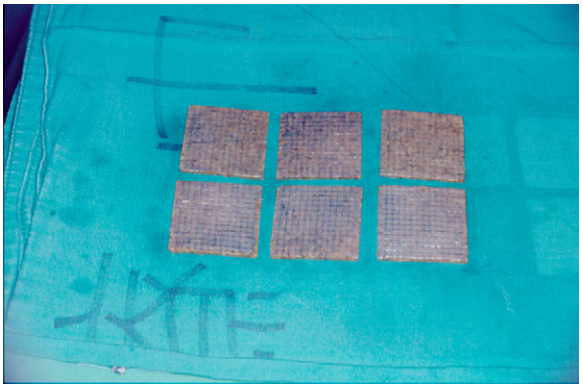

Fig. 4 – The epidermal surface of the graft is sprayed with adhesives.

the graft being sprayed with adhesive (Figs. 4 and 5). The gauze was pulled steadily in all directions until it was completely smooth and flattened (Fig. 6).

The recipient site was cleaned in the usual manner, the graft was applied to the wound bed and the gauze tacked down with surgical staples (Fig. 7). The grafted wound was covered with fine mesh gauze impregnated with neomycin, polymyxin and bacitracin ointment. The operative sites in the trunk and

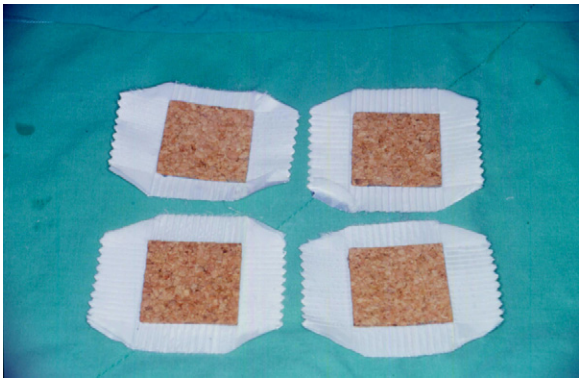

Fig. 5 – The cork is removed once the minced grafts are transferred to pre-folded polyamide gauze backed with aluminum foil.

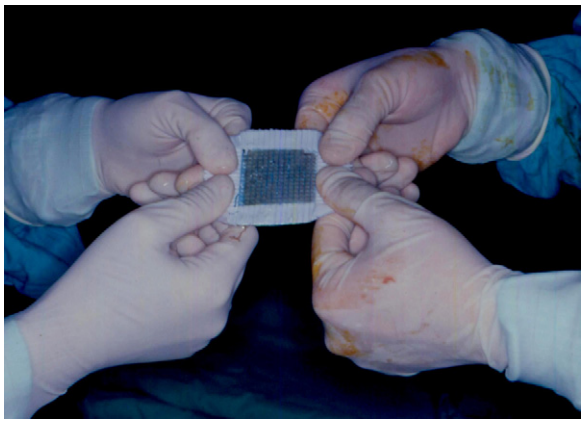

Fig. 6 – The gauze is pulled steadily and firmly in all directions until it is completely smooth and flattened.

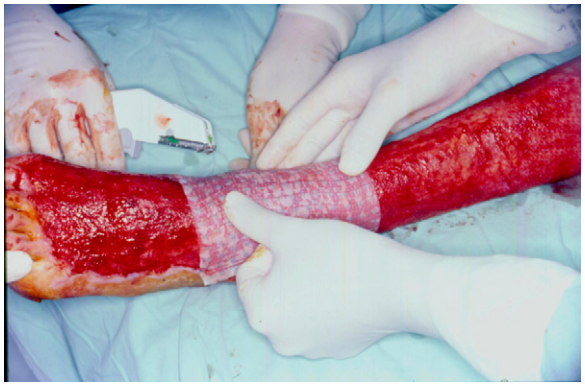

Fig. 7 – The skin graft is applied onto the wound bed and the edges of gauze are tacked down with surgical staples.

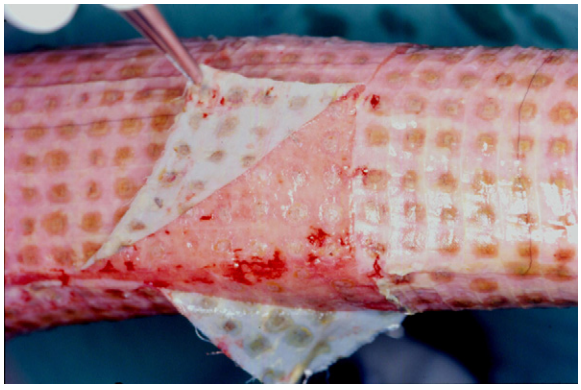

Fig. 8 – The appearance of the grafted wound at the 10th day after the procedure. The viability of the graft was assessed as satisfactory.

extremities were additionally dressed with wet cotton bolsters and then wrapped with elastic bandages.

The wound was left undisturbed for 2–3 days. The wound care regimen consisted of dressing removal, cleansing of the wound with Betadine solution and re-dressing of the wound with gauze soaked in iodine solution. Although the dressing could be changed daily, staples were left undisturbed for 7–10

Fig. 9 – The appearance of the right lower leg 3 years after grafting. Healing is complete and the scarred skin is soft and pliable.

days. The viability of skin graft was assessed at the end of 10th day (Fig. 8); 1% silver sulfadiazine cream was used to cover the wound if the appearance was poor.

3. Results

As shown in the Table 1, the average size of graft at each operation was 13.8% (8%–25%) of the area involved. The viability of the graft as assessed on the 10th day was generally in the range of 90%–95% (Fig. 8). As healing progressed, the texture of scarred skin in the area grafted, as noted 3 years following the injury, became soft and pliable (Fig. 9). No attempts, however, were made to study the incidence of scar contracture or scar hypertrophy among this group of patients.

When initial graft application failed, infection or haematoma were most commonly responsible. Although blood replacement was prescribed as needed in the operating theatre, transfusion seldom exceeded two units per session. Mortality was 10.8%; adult respiratory distress syndrome and massive upper gastrointestinal haemorrhage caused three deaths. A fourth patient with pulmonary burns died of pneumonia 7 months later.

4. Discussion

The regimen of early wound debridement and early wound coverage with autologous skin graft has been shown to reduce burn mortality [4–6]. Although removal of dead skin and covering the wound with patient's own skin may be carried out in one stage if the area of injury is small, the consequences of blood loss and difficulty in wound coverage often preclude the one-stage operation for individuals with extensive burns. A sectional approach of wound debridement according to the body topography is, in this sense, practical.

We arbitrarily divided the body surface into six regions: head and neck, anterior torso, posterior torso, right and left upper extremities, right lower extremity and left lower extremity. First we treated the extremities because these are, in our experience, the easiest and most convenient sites for wound care; bleeding is easily managed with pressure. We treated the head and neck last because in this region vascular patterns make open wounds more difficult to manage.

Autologous skin grafting procedures are frequently hindered by limited donor sites. Thus, the piecemeal use of small fragments of graft, i.e. the postage stamp grafting technique, may be advocated, although this was originally designed to enhance the viability of grafts [1,7,8].

Of the various biological dressings used to dress an open wound, cadaveric skin is the most effective, particularly if the dressing is required to cover an area grafted with small fragments of autologous skin (micrografts). In practice xenographic material, i.e. porcine skin either fresh or treated, is used instead. We have found no technical or clinical problems attributable to the involvement of porcine skin.

Although various techniques of skin graft expansion have been advocated [1,7–9], the technique of meshing a piece of partial-thickness graft advocated by Tanner is still the mainstay of the regimen for wound coverage [2], increasing the extent of wound coverage from two- to six-fold. Application of the graft is technically simple and the wound requires minimal care. On the other hand, meshing a small or fragmented graft can be difficult in practice and available donor sites are often limited. Effectiveness can be impeded also if the ratio of expansion is in excess of 1:6 [10]. In general, these approaches were found cumbersome and wound coverage was unpredictable [8,11,12].

Skin grafts fabricated by the Meek technique, as originally described, may be classified as a micro-postage grafts or micrografts. Regardless of the difference in semantics, the Meek technique of graft cutting is, as noted by Zermani and Hadjiiski, much more mechanically precise, but technically more cumbersome and incurring relatively high costs [13,14]. As described, cutting a piece of skin graft limited in width to 2 in. by using a 2-in. blade or the Humeca D42 dermatome, and then trimming it on a cutting board, substantially reduced the time taken in graft preparation. The higher success rate compared with other methods reduces the cost of patient care by shortening hospital stay, which offsets the alleged high cost of the setups.

The rapid re-epithelialisation with the Meek micrografts observed by others [10,13–16] was also noted in our cases. Possibly this could be accounted for by the short distance between grafts, namely 8–9 mm with a graft maximally expanded by 1:9, compared with 11–12 mm in a Tanner meshed graft expanded by 1:6.

Infection, as noted in our cases, was a common cause of graft failure. Although the thickness of skin graft used for wound coverage does not seem to affect the incidence of infection, small postage stamp skin grafts appear to be more resistant to invasion by microorganisms. By inference, it is conceivable that a piece of skin graft with interconnecting skin bridges, as in a meshed skin graft, could be less tolerant of infection. We have observed in our study successful re-epithelialisation of a grossly contaminated wound covered with a 1:6 Meek graft.

Although various techniques such as allograft overlay or cultured epithelial autograft have been advocated to promote re-epithelialisation processes in a wound covered with 1:9 or 1:6 expanded Meek grafts [10,14–16], we did not use these. Instead, we followed the regimen described above, including

antibiotic ointment-impregnated paraffin gauze dressing changed daily. Complete re-epithelialisation was noted in 7–10 days for individuals grafted with 1:4 expansions, 2–3 weeks with 1:6 expansions and 1 month with 1:9 expansions.

Functional and aesthetic outcomes of wounds treated with Meek grafts are, in most instances, satisfactory (Fig. 9). The rationale for these favourable outcomes remains unclear, but the results are probably also governed by the depth of wound and the extent of graft expansion. Problems such as scar contracture and hypertrophic scar formation have persisted in a small number of our cases.

5. Conclusions

Our experience in using the modified Meek micrograft technique for burn coverage suggests that the technique is effective in covering an extensive burn, and that it is particularly useful when graft donor sites may be inadequate. Management is simpler and more efficient when a scheme comprising topographical division of the body surface and an order in wound care and coverage is incorporated. The technique is strongly recommended for consideration in the management of extensive burns.

Conflict of interest statement

None.

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