42 The Meek–Wall Micrograft Technique

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Introduction

Extended areas of full-thickness burns require, after surgical excision or debridement of non-viable tissue, specific grafting techniques for closure of the wound surface.

During the 1960s, techniques for the expansion of split skin autografts became available. The first of these expansion techniques was the Meek-Wall method [1], in which a regular distribution of postage stamp autografts was produced by expanding cut squares of split-skin autograft on specially prefolded gauze. The technique was cumbersome, but the expansion of 1:9 achieved by this method remains unsurpassed by the mesh-graft techniques introduced later [2]. However, the open, grafted wounds were prone to dehydration and infection, and the average take with expanded autografts was unsatisfactory.

In patients with burns of up to 35% of the total body surface area (TBSA), early excision and primary coverage with autografts, meshed if necessary, is technically straightforward, as sufficient donor sites are generally available. With burns of 35–65%, a lack of donor sites might require an intermediate phase, in which areas that cannot be directly covered with autograft may be temporarily protected by the application of allograft skin, while donor sites heal sufficiently to be harvested again. For patients with injuries greater than 65%, Burke proved that long-term wound coverage with allografts could be achieved by administering immunosuppressant drugs to prevent allograft rejection, providing time for repeated harvesting of the limited donor sites available for autografts [3].

In the last two decades of the 20th century, the use of mesh grafts has been further improved by the introduction of the so-called sandwich technique, in which the (widely) expanded split skin autografts were covered with a layer of (meshed) split skin allograft [4].

Cryopreserved Allografts

When cryopreserved allografts became available, fears of immunological reactions restricted the use of allografts to their short-term application as a biological dressing. Thus, allografts were initially employed as a temporary cover for partial skin thickness burns, and a marked improvement in cosmetic results was obtained [5]. Allografts were also used on excised wounds on which autografts had failed to take [6]. Wounds treated in this way improved and became free from infection.

However, despite an initial satisfactory take of both autograft and allograft layers, epidermal outgrowth was frequently disrupted during the second or third week by immunological rejection of the allograft component, which occasionally resulted in loss of the entire graft. These experiences suggested that results might be improved if the allografts could be modified to reduce their antigenicity.

Glycerol-Preserved Allografts

Interest in the use of glycerol as a preservative for allografts was prompted by observations that allografts lyophilised by freeze-drying displayed reduced antigenicity [7]. However, the technique of freeze-drying was complex and expensive, and, in a series of laboratory experiments in collaboration with the Dutch Skin Bank, it was found that lyophilisation could be achieved more simply by 98% glycerol. By replacing tissue water by glycerol, the structural integrity of the allografts remained optimally preserved [8]. Studies on a porcine model confirmed that the inflammatory response evoked by glycerol-preserved allografts was milder than that evoked by viable donor skin. Encouraged by favourable results obtained elsewhere with glycerol-preserved xenografts [9], non-viable glycerol-preserved allografts were introduced in the clinic [10].

More recently, different artificial products have been manufactured to achieve wound coverage in extensive burns. These products are, among others: Biobrane, a semi-permeable silicone membrane bonded to nylon to which peptides of porcine collagen have been added [11, 12] and Integra, a bilayer membrane system of a bovine tendon collagen and glycosaminoglycan layer on a silicone layer [13, 14]. Although Integra seems to be the most promising skin substitute presently available, its use is limited by costs and complications during the ingrowth phase of the treatment [15, 16].

Skin (Meek) Micrografting

An ingenious method for obtaining widely expanded postage-stamp autografts was described by Meek, in which prefolded gauzes were used to achieve a regular distribution of autograft islands cut with a Meek–Wall dermatome [1, 17]. Despite the ninefold expansion obtained by this method, the technique became eclipsed by the introduction of mesh skin grafts [2]. Manufacture of the dermatome and pre-folded gauzes was eventually discontinued, and the method was in danger of fading into obscurity.

However, with the improved early survival of patients with extensive burn injuries, lack of autograft donor sites was increasingly encountered as a limiting factor in achieving wound closure. Mesh grafts required the presence of suitable donor

sites, and epithelisation was delayed with expansion ratios of greater than 1:6. In collaboration with the Dutch instrument manufacturer HUMECA (Enschede, The Netherlands), the Meek technique was reintroduced in our clinic. The materials were modified and improved considerably, and the dermatome was adapted to run on compressed air. Furthermore, the components were enlarged to allow expansion of larger pieces of autograft [18].

Patients and Methods

Operative Procedure

At operation, wounds to be grafted were excised down to the underlying fascia and haemostasis was secured.

Split-skin autografts were obtained following standard procedures. A cork square, measuring 4.2×4.2 cm, was dampened, and the graft spread, dermis side down, on the cork and – if necessary – was trimmed to size (smaller graft remnants are also suitable). The cork containing the graft was placed in the carrier block of the dermatome and was secured by a grill. The carrier block was then passed through the dermatome, containing 13 parallel blades, spaced 3 mm apart. The blades cut through the graft and into, but not through, the cork. After the first pass, the grill was carefully removed; the cork with the graft was rotated 90° reclamped, and passed through the dermatome once more, thus cutting the graft into 14×14 small squares measuring 3×3 mm (materials: HUMECA) (Fig. 1).

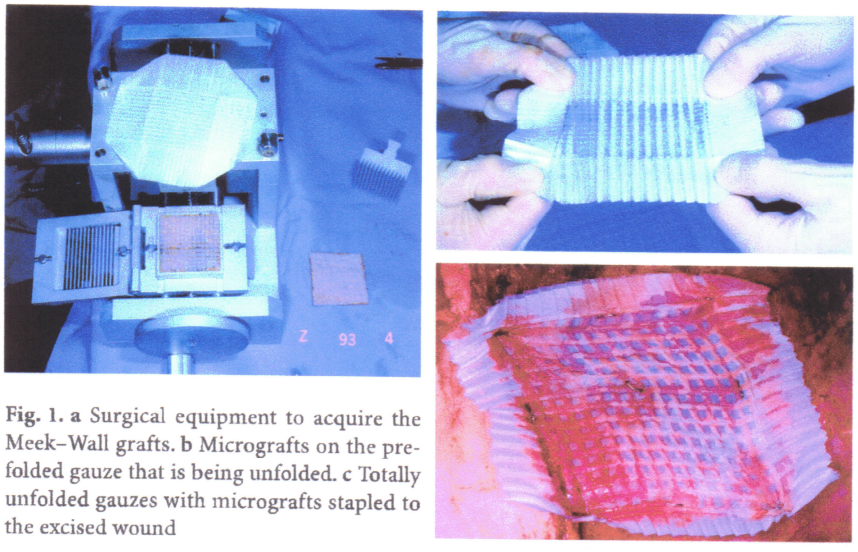

Fig. 1. a Surgical equipment to acquire the Meek–Wall grafts. **b** Micrografts on the pre-folded gauze that is being unfolded. **c** Totally unfolded gauzes with micrografts stapled to the excised wound

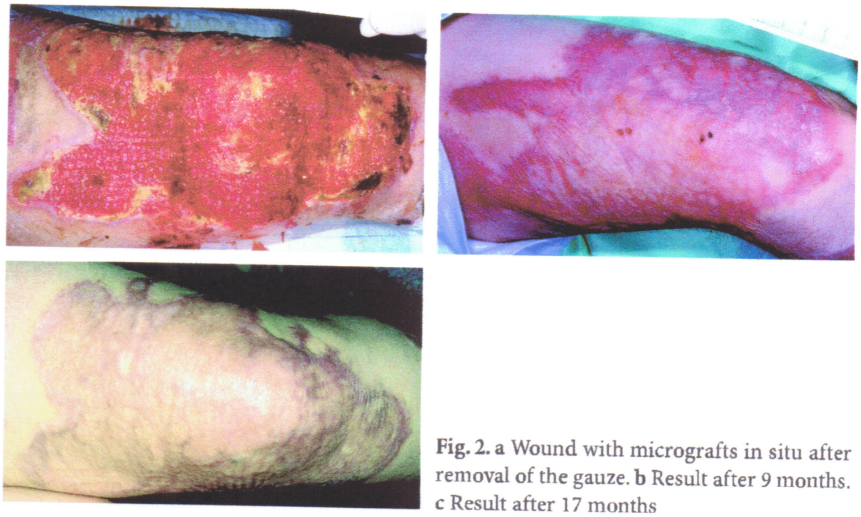

Fig. 2. **a** Wound with micrografts in situ after removal of the gauze. **b** Result after 9 months. **c** Result after 17 months

The grill was carefully lifted off. A specially serrated wedge, supplied with the dermatome, was used to hold the grafts in place on the cork while the grill was loosened.

The cork, with the cut graft in place, was removed. The upper (epidermal) surface of the graft was sprayed with an adhesive dressing spray (Leukospray, Beiersdorf GmbH, Hamburg, Germany), and allowed to become tacky. The pre-folded polyester gauze, which is folded on an aluminium foil backing into a series of square pleats corresponding to the cuts in the autograft, was pressed onto the graft for a few seconds, after which the cork square was gently removed, leaving the graft islands adhering to the gauze. The gauze was pulled out by firm traction on all four sides, until the pleats became completely unfolded. Finally, the aluminium backing was peeled off, to leave the expanded gauze with the separated, adherent autograft islands ready for transplantation. After trimming the margins, the gauze was applied, graft side down, to the wound bed, and secured with surgical staples (Fig. 2).

The gauzes were covered with dressings soaked in different local therapeutics, such as silvernitrate in polyethyleneglycol, Betadine in polyethyleneglycol or Furacine depending on the wound cultures taken. The dressings were changed on a daily base.

After six days the grafts had grown sufficiently into the wound bed to allow removal of the gauze. At operation, the staples were removed and, using blunt forceps, the gauze was gently detached, leaving the autograft islands in situ on the wound bed. The grafts were covered with an overlay of glycerol-preserved allografts, meshed 1:1.5, and secured with either Adaptic or Cuticerin. After a further 6 days, when the allografts were firmly adherent to the wound, this dressing was removed. Daily dressings were continued until epithelisation was complete. Details of the general surgical procedure have been described previously [18].

Patient group

A total of 128 Meek–Wall procedures were analysed retrospectively in 49 patients. In this patient group, 7 of the 49 patients suffered from diabetes mellitus, 8 patients had inhalation trauma. Mean TBSA was 34±20% (range 5–84%), with a percentage of third-degree burns of 25±17% (range 4–83%).

Since it was impossible to systematically obtain end results, e.g. cosmetic results, from retrospective data analysis, we have chosen the take rate of the graft as the primary effect parameter. An experienced surgeon of the burn-care unit performed the estimation of the take rates between the fifth and the seventh post-operative day. Take rate was defined as the percentage of the transplanted area, adherent to the wound bed, which retained a vital appearance [19].

Earlier clinical observations suggested that the percentage of total body surface area burned and the percentage of third-degree burns (TBSA3) could have an effect on wound condition and wound healing in general. The TBSA percentage treated was determined peri-operatively in each procedure.

The semi-quantitative laboratory testing of culture swabs on the presence of bacteria provided a grading ranging from – (none) to +++ (multiple colonies of a species). Only culture swabs taken in a period ranging from 4 days before till 7 days after the surgical procedure were evaluated. Different bacterial species pose different threats to normal wound healing [20, 21]. A wound was considered to be contaminated, when its swab culture identified one or more of the species of *Pseudomonas*, *Staphylococcus* or *Streptococcus* in sufficient (estimated +++) amounts. Slight contamination was defined as a comparable or less extensive (estimated – to ++) wound-bed contamination with other species.

Statistics

Statistical analysis was performed with SPSS. A multiple linear regression analysis was performed using the graft take rate as the dependent variable. Statistical significance level was determined at $p<0.05$.

Results

The influence of various independent variables, such as TBSA, level of contamination of the wound, method of debridement, presence or absence of inhalation trauma and expansion of the grafts on the take of the grafts was evaluated retrospectively in a total of 128 Meek–Wall procedures in 49 patients. The primary effect parameter, the average graft take rate, was 76.6±18% and ranged from 20 to 100%.

Multiple linear regression analysis showed a difference of 12.4% in take rate, favouring avulsion over tangential excision. This relation, however, was just outside the defined limits for statistical significance ($p=0.059$). The presence of diabetes as a systemic disorder resulted in a significant reduction in take rate of 14.5% ($p=0.008$).

Table 1. Graft expansions with respective take-rate percentages

Expansion Ratio	Mean take rate [%]	Standard deviation [%]	Frequency in n=128 [%]
4/1	76	14	13
6/1	76	18	73
9/1	78	20	14

Other independent variables, including bacterial contamination, TBSA as well as inhalation trauma, failed to prove a statistically significant relationship with the dependent variable take rate.

Also the influence of the expansion ratio, an important aspect of the Meek–Wall procedure, on the take rate of the grafts was investigated. In this patient population the following ratios were used: 4/1, 6/1 and 9/1, their averaged take rates are summarised in Table 1. The differences in take rate between the different expansions were not statistically significant.

Discussion

The regression analysis showed that the take rate of grafts applied to a wound bed after avulsion was slightly, but not statistically significantly, better than when used on a wound bed prepared by tangential excision. One could envisage that debridement by avulsion is more extensive than by tangential excision, resulting in a wound bed that is essentially free of necrosis. The presence of diabetes as a systemic disorder resulted in a significant reduction in take rate of 14.5% (p=0.008). This is not surprising, since impaired wound healing is a well-known phenomenon in diabetes mellitus [22, 23]. All the other independent variables enrolled in this analysis did not show a statistically significant effect on the take rate of the micrografts.

It is remarkable that factors such as TBSA (TBSA3) and inhalation trauma did not show a significant relation to the take rate. Apparently, the modern intensive care meets the needs for an adequate maintenance of wound-bed perfusion in the more extensively burned patients. Taking into account that no grafts were placed when a clinical wound infection was obvious, we still expected lower take rates whenever the wound was bacterially contaminated in the peri-operative period. Apparently, these subclinical infections posed no real threat to the take of grafts since no significant effect on the take rate could be demonstrated.

The small areas of donor site needed when using Meek–Wall grafts is seen as its biggest advantage. Therefore, the expansion ratios were examined to determine which ratio resulted in the best take rate. Also here no statistically significant differences could be found, suggesting that the choice of a specific expansion ratio does not affect the take of the graft. It should be realised, however, that less skin is applied on the wound by a largely expanded graft, so the healing time will be longer.

The results reported suggest that, in combination with an overlay of glycerol-preserved allografts, the Meek technique provides reliable wound healing with autografts expanded to a ratio of 1:9. he delay in applying the allograft overlay did not appear to affect graft take. Although the need for a second operative procedure is a relative disadvantage, we found in practice that the application of allografts could often be staged to coincide with some other procedure in these extensively injured patients.

Furthermore, our results, as well as those from others, indicate that micro-island grafts, in contrast to mesh grafts, show a remarkable survival under poor wound conditions [24, 25].

In conclusion, the sandwich Meek micro-graft technique has proved to be a practical and reliable method for obtaining widely expanded autograft islands when donor sites are scarce. The technique has reached a wide area of acceptance [26, 27] and has become the method of choice when insufficient donor sites are available to achieve primary wound coverage with mesh grafts. Meek–Wall micro-grafting can be used in patients with large TBSA, patients with an inhalation trauma, in the case of a contaminated wound bed, or particularly when large graft expansion ratios (up to 9/1) are needed. These conditions do not significantly affect the take rate of this procedure.

Intriguing are efforts in the combined use of Integra and Meek micrografts after ingrowth of he dermal part of Integra and removal of the silicon outer sheet [28].

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