Expansion techniques for skin grafts: comparison between mesh and Meek island (sandwich-) grafts

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In skin grafting operations for patients with extensive burn injuries, mesh techniques are often employed to enlarge the effective surface area covered by autografts. However, substantial strips of autograft are required and the distribution of autograft elements on the wound surface is relatively uneconomical. An alternative technique for expanding autografts, first described by Meek in 1958, makes use of a special dermatome and prefolded gauzes to obtain a regular expansion of autograft squares from small pieces of split skin grafts. In a simple in vitro *experiment using allograft skin, the expansion ratio obtained with the Meek micrograft technique was measured at almost 1:9. In contrast, the expansion ratio obtained with allograft meshed '1:6' with a Zimmer Dermatome II was measured at 1:4. The maximum distance between the graft elements obtained with the Meek technique was 9 mm, compared to a maximal distance between the strands of the mesh graft of 12 mm. The Meek technique is a useful alternative to mesh grafts when donor sites are limited. Clinical experience suggests that Meek grafts are also particularly suitable for grafting on granulating wounds under poor conditions.*

Introduction

Techniques for expanding the effective surface area of autologous skin grafts are frequently applied in the surgical treatment of extensive full thickness burn wounds. When very widely expanded autografts are employed, epithelialization is improved by adding an overlay of perforated allograft to protect the open wound bed (Alexander et al., 1981; Kreis et al., 1989).

Since the introduction of the mesh graft (Tanner et al., 1964), meshing techniques have become the most popular method of skin expansion in the West. However, the method requires long strips of autograft, and a lack of suitable donor sites may be a limiting factor in patients with extensive injuries. Alternative methods based on the Chinese 'postage stamp' technique (Li and Yang, 1981; Yang et al., 1982) make more economical use of available autografts, but the original procedure is extremely labour intensive and time consuming. The investment in apparatus required to mechanize the procedure (Hettich et al., 1992) is beyond the reach of most centres.

An alternative expansion technique, first described by Meek (1958, 1963), has recently been revived in our unit. Autograft expansion is achieved by spray-gluing small autograft pieces, cut with a dermatome into 3 mm × 3 mm squares, on to special prefolded gauzes. When the gauze is unfolded, a regular distribution of small autograft islands is produced, ready for transfer to the excised wound. After 6 days, when the islands are firmly attached to the wound bed, the gauze can be removed and an allograft overlay applied. The technique has recently been described in detail (Kreis et al., 1993).

In this paper, a simple *in vitro* study is described which compares the Meek technique of autograft expansion to the familiar mesh technique.

Materials and methods

A strip of preserved human split skin (Strip A) was trimmed to a rectangular shape and dyed deep-blue by immersing in indigo carmine. After drying, the strip was laid on white paper and photocopied 1:1 to facilitate accurate measurement. The strip was then meshed '1:6' with a Zimmer Dermatome II (Zimmer; Dover, Ohio, USA) and again photocopied after maximal expansion. The areas covered by the unmeshed and meshed skin were calculated (*Figure 1*).

A second strip of split skin (Strip B), from the same donor, was trimmed to a size of 4 cm × 4 cm, to fit the cork carrier of a complete redesigned Meek micrograft dermatome (Humeca; Enschede, The Netherlands). This strip was similarly dyed before being applied, dermal side down, to the

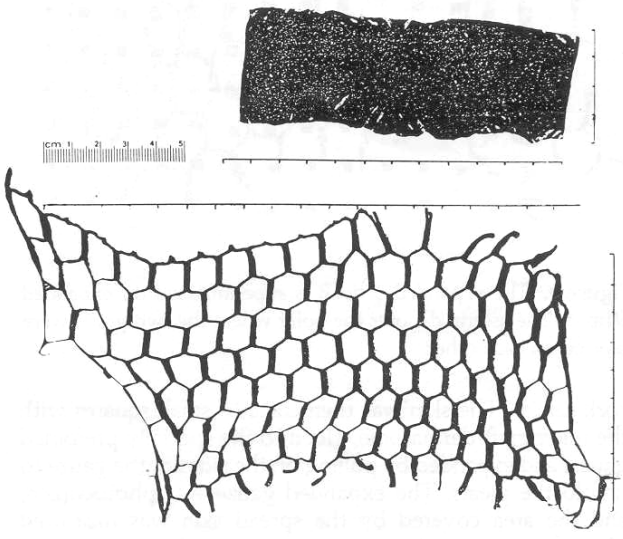

Figure 1. Allograft Strip A before and after meshing with a '1:6' Zimmer Dermatome II.

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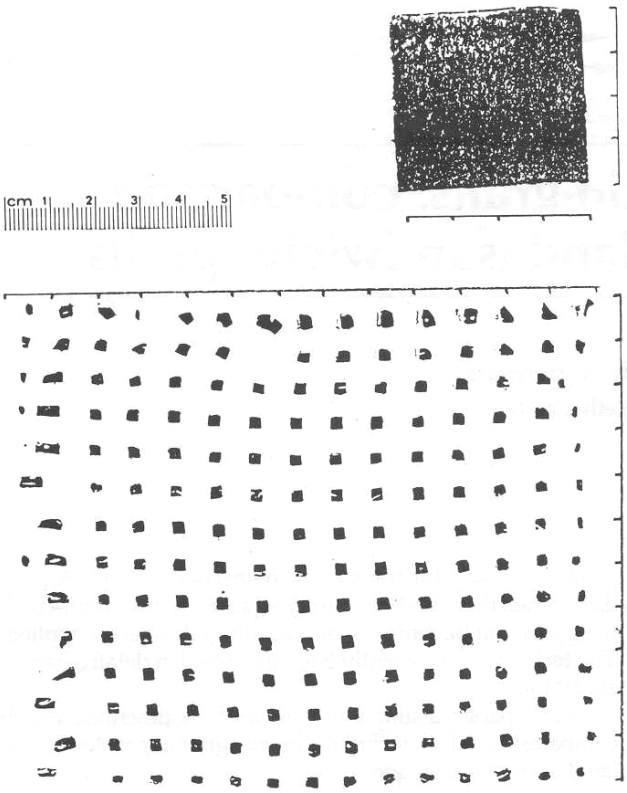

Figure 2. Allograft Strip B before and after expansion with the Meek technique.

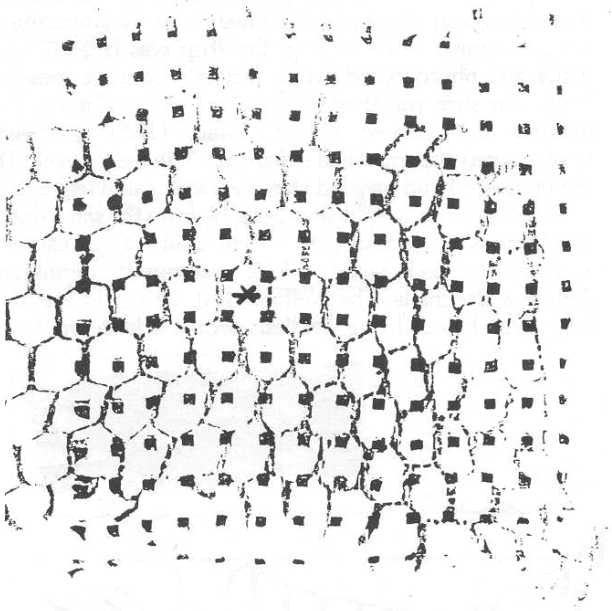

Figure 3. The expanded Strip B is superimposed on expanded Strip A. The asterix denotes the point where the two grafts were centred on each other.

cork carrier. The skin was then cut into small squares with the micrograft dermatome, glued to the specially prefolded gauze, and expanded by pulling on the sides of the gauze to unfold the pleats. The expanded gauze was photocopied, and the area covered by the spread skin was measured (*Figure 2*).

Finally, to illustrate the relative efficiency of distribution of the epidermal elements, a further photocopy was made of both expanded skin samples, one superimposed on the other (*Figure 3*).

Results

The rectangular strip A measured 12 × 4 cm before meshing. After meshing and maximal spreading, the strip measured 19 × 9 cm (*Figure 1*). The expansion ratio achieved by the '1:6' meshing procedure was therefore 1:4.

The square strip B measured 4 × 4 cm prior to expansion. After expansion with the Meek technique, the squares measured 12.5 × 11 cm. The expansion ratio obtained by the Meek technique was therefore 1:9 (*Figure 2*).

The maximum distance between allograft elements obtained with the mesh technique was measured at 11–12 mm, while the maximum distance between the Meek islands was 8–9 mm. The improved distribution of skin elements obtained with the latter technique is illustrated by the two superimposed expanded samples (*Figure 3*). An asterix in the centre of the figure indicates where four of the Meek islands coincide with a hexagonal of the mesh pattern.

Discussion

The main advantage of mesh grafts is their ease of application, with a consequent reduction in operating time. However, at expansion ratios of more than 1:4, the wound bed is prone to desiccation and epithelialization may be disturbed (Kreis and Vloemans, 1987).

Although protection of the wound bed is enhanced by an overlay of split skin (xeno-)grafts (Bohmert et al., 1971), expansion ratios of more than 1:6 remain impractical: the mesh becomes difficult to manipulate and long strips of autograft are required, which are often unavailable in patients with extensive injuries. The discrepancy between the theoretical expansion ratio and the actual expansion ratio obtained with mesh grafts found in this study has been previously demonstrated (Peeters and Hubens, 1988; Richard et al., 1993).

The limitations of mesh grafts have prompted interest in the technique of micrografting (Zhang et al., 1988; Fang et al., 1988; Fang and Alexander, 1990; Shvets et al., 1991; Lin et al., 1992). Small pieces of split skin are snipped with (circular) knives or scissors and, sometimes by sieving through gauzes, spread over the wound surface with or without an overlay of allo- or xenogeneic skin grafts. Despite the uncontrolled distribution and orientation of the epidermal elements, consistent results have been reported with expansion ratios of up to 1:12 (Mardovin et al., 1992). However, the practical applicability of this rather complicated technique has yet to be established.

The Meek technique employs prefolded gauzes to produce a regular distribution of correctly oriented (dermal side down) autograft islands, but suffers the disadvantage that the allograft overlay can only be applied after a delay of 6 days, when the islands have grown in sufficiently to allow removal of the gauze. In our experience, however, this delay has not been shown to be a significant problem.

Recent clinical experience in our unit has highlighted an additional advantage of the Meek method when applied to granulating wounds and wounds of poor quality. As the autograft islands are not mutually connected, failure of a few islands does not necessarily affect the overall graft take. In contrast, detachment of a small area of mesh graft can result in large segments of graft becoming dislodged during dress-

Figure 4. **a,** A 65-year-old patient sustained a 40 per cent deep full thickness burn after falling into a hot bath during an epileptic seizure. The burn in the right flank includes the iliac crest and lower ribs. **b and c,** Shows staged debridement: Meek grafts are applied to granulating areas as they appear. **d,** Outpatient follow-up at 10 months postburn.

ing changes. The surprisingly high take of Meek grafts under relatively unfavourable circumstances has aroused interest in Benmeir's report that autograft postage stamps are superior to mesh grafts in these situations (Benmeir et al., 1991) . The observations have prompted us to extend the indications for the Meek technique to very deep burns in which complete primary debridement is not possible. In these cases, serial debridement coupled with application of the Meek islands to granulating areas as they appear, has proved effective (*Figure 4*).

In conclusion, we have found that when expansion ratios of more than 1:6 are required, the Meek technique is superior to mesh procedures. The expansion ratio is consistent and the distribution of autograft elements on the wound surface is more economical. Meek grafts appear to be particularly suitable for serial grafting on granulating wounds under poor conditions.

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Delegates' discussion

Hermans, Beverwijk:
We used the Meek-Wall technique 30 years ago, and it was discarded when the mesh graft came as it is a very labour intensive procedure. When we first performed it, the glue was difficult to place accurately and later when we came back to the procedure, found that we could no longer obtain the prefolded bandages.

Kreis, Beverwijk:
Using Meek Islands, covering with the allograft is essential after early excision. We also redesigned the machine and the prefolded bandages. The gluing procedure was improved by a spray technique which is much more convenient. Now it is fairly well standardized, with only a few difficulties.

Sauer, Gröningen:
You were trying to demonstrate the influence of the allograft on the healing. You showed that after you took the cover off the mesh graft, it was mostly healed within 6–7 days. Then you put a donor skin on before the Meek-Wall technique – is that right?.

Kreis:
Yes. There was a granulating wound bed and we applied a mesh graft expanded 1:3. In that situation we do not apply an allograft.

Sauer:
So even without allograft it can heal quite well.

Kreis:
Yes. In some cases, Surfasoft can act in a similar way to an allograft in preventing desiccation. However, in a mesh graft expanded 1:6 or more, Surfasoft is not suitable for that purpose and you need an allograft.

Sauer:
If you compare the Meek island with the mesh graft which forms a network over the wound, I expect a better quality of the skin with the combination of mesh and allografts.

Kreis:
Cosmetically that may be correct but, mathematically, you have a shorter re-epithelialization time with the Meek-Wall procedure. Cosmetically, I agree with you. However, when we talk about life-saving procedures or when you need to save skin for the face or the hands, the Meek-Wall technique is clearly superior.

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