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Original research

Skin graft meshing, over-meshing and cross-meshing

James Henderson [a], Reza Arya [a,*], Patrick Gillespie [b]

[a] St Andrew's Centre for Plastic Surgery and Burns, Broomfield Hospital, Court Road, Chelmsford CM1 7TT, UK
[b] Addenbrooke's Hospital, Cambridge, UK

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ABSTRACT

Introduction: Split skin grafts (SSGs) are often meshed to increase their size and allow exudate to escape. We investigated the expansion obtained with meshing, and the possibility of re-meshing skin that has already been meshed ("overmeshing"). Both useful and inadvisable permutations are illustrated.
Material and methods: Thin porcine SSGs were sideways meshed, or meshed with ratios of 1.5:1 and 3:1. Subsequently samples were over-meshed in a variety of ratios and directions. All grafts were maximally expanded and their areas calculated.
Results: Meshed skin did not expand as much as suggested by the ratios displayed on dermacarriers. A 1:1.5 dermacarrier produced an area expansion of 1.36×, and a 1:3 meshing apparatus produced only a 1.80× area expansion.
Several combinations of twice-meshed SSGs maintained integrity as long as over-meshing was done in the axis of initial meshing. Up to 2.3× expansion was obtained, by following a 1:1.5 mesh with a 1:3 mesh. We term this procedure as "overmeshing". Re-meshing in a direction orthogonal to initial meshing (cross meshing) cut the skin into small pieces.
Conclusion: Over-meshing a SSG can allow considerable further expansion, facilitating overgrafting of donor sites or simply increasing the area that can be covered with the existing harvested skin.

1. Introduction

Described by Lanz in 1907[1] meshing increases the area that can be covered by a split skin graft, whilst improving take rates by preventing haematoma or seroma accumulation and also allowing better graft application to irregularly contoured surfaces.[2]

Meshing can be performed by hand, or more consistently, by machine. Different ratios of expansion can be obtained by using different graft carriers (dermacarriers) or interchangeable blades on meshing machines. Ratios of 1:1.5 and 1:3 are commonly used, although it has been shown that these may equate to actual expansion ratios of only 1.2× and 1.5× respectively.[3]

The degree of expansion of meshed skin is determined by the angle between the blades of the mesher and the ridges of the dermacarrier, and this can be altered by modifying the dermacarrier.[4] Smaller perforations in split skin grafts that allow only minimal expansion ("micromeshing") can be created by passing the skin through a mesher with the 1:1.5 dermacarrier sideways.[5] Skin perforated in this way is stronger and cosmetically more acceptable than fully meshed skin, but of course cannot be expanded to cover a larger area.

Returning spare harvested skin to the donor site ("overgrafting") has been found to decrease healing time and wound morbidity, especially in older patients, even if widely meshed.[6] There will never be enough left over skin to graft the entire donor site without a large degree of expansion, possibly necessitating the use of additional carrier boards.

We investigated the effects of meshing skin, and re-meshing skin that has already been through a mesher. The aim was to evaluate the degree of expansion that is obtained with common mesher boards, and to identify possible combinations of meshing and re-meshing that provide useful skin expansion, allowing previously meshed skin to be further expanded, particularly with a view to overgrafting of the donor site.

2. Materials and methods

Thin porcine skin grafts were harvested from commercially purchased pig bellies (Fresh Tissue Supplies, Horsham, UK) with a Watson knife. Grafts were cut to exact 4 cm squares and marked for orientation (Fig. 1), before being passed through a Brennan meshing machine (Eurosurgical, Guildford, UK) on carrier boards as detailed in Table 1. Micromeshing was performed by cutting a 1:1.5 dermacarrier board so that it could be passed sideways through the mesher, making smaller perforations in the skin. After the first meshing procedure, the skin specimen was

* Corresponding author.
E-mail address: reza.arya@gmail.com (R. Arya).

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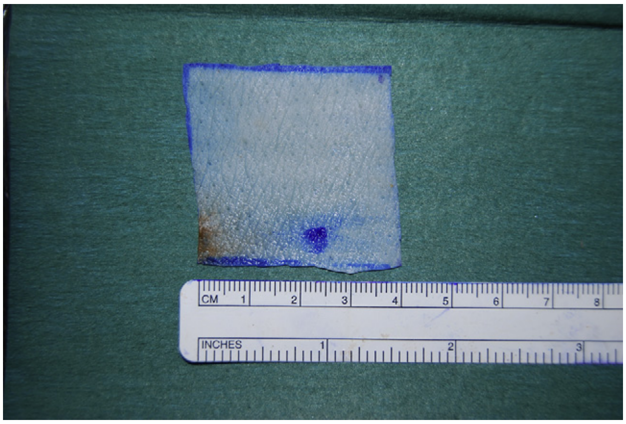

Fig. 1. Four cm square split porcine skin graft marked for orientation before being meshed.

Table 1
Demonstrates the permutations of meshing ratios used for each specimen.

Number	First mesh ratio	Second mesh ratio
1	Micro	Micro
2	Micro	1.5
3	Micro	3
4	1.5	1.5
5	1.5	3
6	1.5	1.5 cross
7	1.5	3 cross
8	3	3

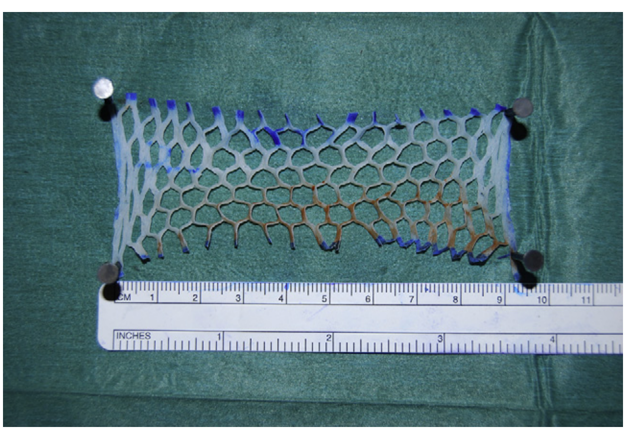

Fig. 2. Single mesh 1:3 expanded. Note that the graft narrows in the centre when stretched out. The graft area expands 1.80×.

meshed a second time, either in the same direction ('overmeshing') or at 90 degrees to the axis of first meshing ('cross meshing') (Fig. 1).

The resulting meshed grafts were expanded as much as possible without damaging them, and pinned out on a board, allowing calculation of their new dimensions and area. All grafts were photographed. When meshed grafts were expanded and pinned out, they tended to develop a narrowing across the central portion (Fig. 2), so for calculation of the area of such grafts, a mean was taken between the widest measurement at the end and the narrowest measurement at the centre.

3. Results

The results of the meshing, overmeshing and cross meshing measurements and calculated areas can be seen in Table 2.

3.1. Primary meshing

Micromeshing (1:1.5 dermacarrier turned 90°) increased the area of the skin graft by a factor of only 1.04 after one mesh. Conventional use of the 1:1.5 dermacarrier led to a 1.37× increase of the area of the graft. Meshing with the 1:3 dermacarrier led to an increase in the size of the graft by a factor of only 1.80 (Fig. 2).

3.2. Overmeshing

Several combinations of meshing and overmeshing resulted in useable skin grafts. Micromeshing followed by 1:1.5 meshing led to a skin area expansion of 1.50× (Fig. 3) whilst micromeshing followed by 1:3 meshing led to a useable 2.0× increase in skin area. The patterns produced by overmeshing are slightly different in appearance from those created by a single pass of skin through a mesher (Figs. 3–5). 1:1.5 meshing performed twice in the same direction led to a 1.81× increase in skin area (Fig. 4), and 1:1.5 followed by 1:3 meshing led to an increase of skin area by 2.3× (Fig. 5).

1:3 meshing performed twice in the same direction led to destruction of the skin graft, producing unusable strands of skin (Fig. 6).

3.3. Cross meshing

Cross meshing using either the 1:1.5 or 1:3 dermacarriers at 90° to the direction of initial meshing led to the creation of useless fragments of skin (Fig. 7).

4. Discussion

There have been few studies looking at skin graft meshing, despite it being a procedure generally performed on a daily basis in every plastic surgery unit. Although most surgeons are aware that skin does not expand to the degree stated on mesher boards, this is little publicised.[3] A mathematical explanation for the expansion of skin grafts after meshing has been elucidated.[7] As expected,

Table 2
Details the results of all permutations of meshing ratios. Note that the last three permutations resulted in unusable strands or fragments of skin graft.

Experiment number	First mesh ratio	Second mesh ratio	Initial area (mm^2)	Area after first meshing (mm^2)	Area after second meshing (mm^2)	Area increase ratio after first mesh	Total area increase after both meshes
1	Micro	Micro	1600	1661	1760	1.038	1.060
2	Micro	1.5	1600	1661	2405	1.038	1.503
3	Micro	3	1600	1720	3255	1.036	2.034
4	1.5	1.5	1600	2184	2888	1.365	1.805
5	1.5	3	1600	2262	3672	1.413	2.295
6	1.5	1.5 cross	1600	2184	N/A	1.365	N/A
7	1.5	3 cross	1600	2128	N/A	1.33	N/A
8	3	3	1600	2886	N/A	1.804	N/A

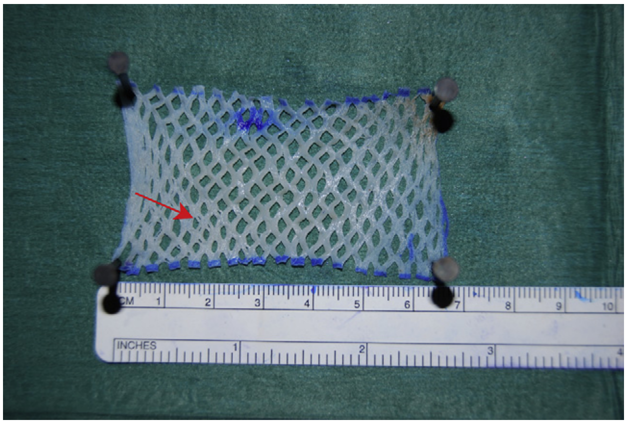

Fig. 3. Micro (sideways) and then 1:1.5 overmeshed skin graft. A few sideways-meshed areas can be seen. The graft area expands 1.50×.

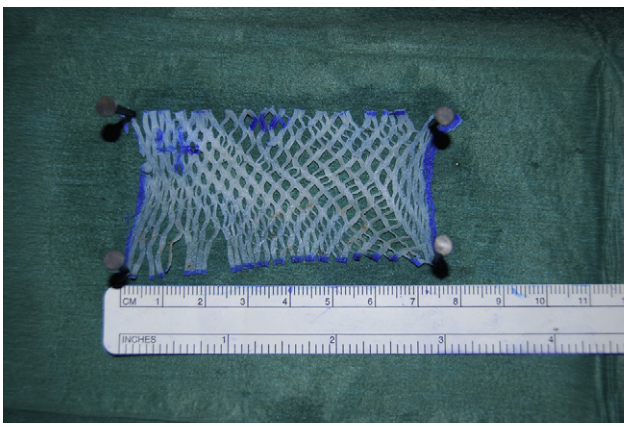

Fig. 4. 1:1.5 then 1:1.5 overmeshed skin graft. Note the pattern of expansion is different to that seen with a singly-meshed graft. The graft area expands 1.81×.

micromeshing did not allow a meaningful expansion of the skin graft.[5] We achieved results with a single pass of skin through the 1:1.5 or 1:3 mesher not dissimilar from those previously found.[3] It is important that surgeons realise that expansions of only 1.4–1.8× are achievable with these dermacarriers.

Passing the skin through the 1:1.5 mesher twice led to the production of useable skin expanded by a factor of 1.81; similar to

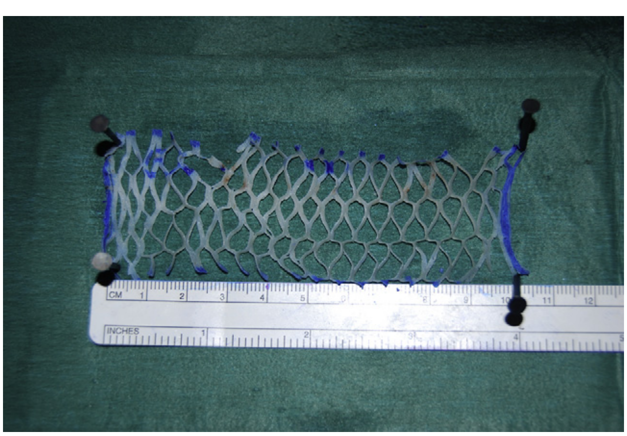

Fig. 5. 1:1.5 and then 1:3 overmeshed skin graft. Note that the pattern of meshing is different to that seen with a singly-meshed graft. The graft area expands 2.3×.

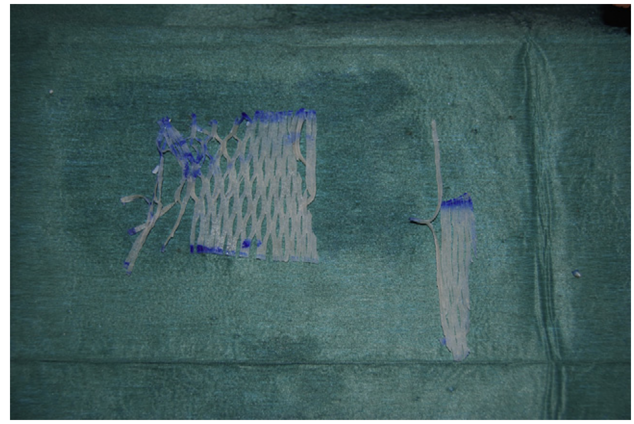

Fig. 6. 1:3 and then 1:3 overmeshed skin grafting leads to unusable strands of skin. We caution against this pattern of overmeshing.

that produced by a single pass through the 1:3 mesher. Surgeons can therefore use the 1:1.5 mesher to produce skin grafts equivalent to those made in the 1:3 mesher. Better expansion still was obtained by the use of a 1:1.5 and 1:3 mesher in sequence, giving a 2.3× increase in graft area. We did not have a 1:6 dermacarrier available to test, and this item is not routinely available in our unit. It would be useful to explore the possible results of meshing and overmeshing with larger-ratio dermacarriers, although as we discovered with 1:3 overmeshing, this might just lead to unusable strips of skin.

Re-meshing previously meshed skin allows skin that has already been meshed but is not required for coverage of the primary defect to be further expanded to use for re-grafting of the SSG donor site. Alternatively skin can be overmeshed to allow coverage of a larger area, for example if the size of the primary defect has been underestimated, or donor site availablility is limited. Overmeshing also allows wider expansion of skin in circumstances where an appropriate mesher board may not be available.

We suggest that overmeshing of skin in the combinations micro or 1:1.5 followed by 1:1.5 or 1:3 may be a useful additional technique, but caution against accidental sideways meshing (cross-meshing) of previously meshed skin, or use in combinations of 1:3 and 1:3, as these lead to fragments of skin that are of no use for conventional skin grafting; such fragments may, however, be of use for "micro skin grafting".[8] We accept that in this study we have not formally assessed the effect of additional trauma from a second meshing on the survival or 'take' of the skin graft in the clinical setting.

Fig. 7. Care must be taken to avoid passing the skin through the mesher for a second pass at 90° to the primary mesh, as this cuts the graft into small fragments unusable for conventional grafting.

Ethical approval

No ethical approval was required.

Non-living animal material was purchased from Fresh Tissue Supplies, Horsham, UK.

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Author contribution

All authors have significantly contributed to all stages of the study including design, data collection, analysis and writing.

Conflict of interest

None.

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