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Modification of Split Skin Expansion–A Comparative Study of Hand Diced Skin and Sheet Skin Graft in the Coverage of Wounds

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Abstract

Background: *Large areas of skin loss require skin replacement to minimize scarring and other morbidity. Patients with insufficient donor skin require modification of the usual method of skin grafting to achieve adequate coverage.*
Objective: *This study was designed to compare skin graft take after resurfacing skin defects with sheet skin and hand diced skin.*
Methods: *Twenty consecutive patients who required skin grafting had their wounds covered partly by sheet skin and partly by hand diced skin, thus acting as their own controls.*
Result: *The mean 'take' after five days of grafting was 96 $\pm$ 5.7% for sheet graft and 69.2 $\pm$ 31.5% for diced skin. The signed rank test for paired samples revealed that percentage take after sheet skin grafting was statistically higher than percentage take after grafting with diced skin, $p < 0.001$.*
Conclusion: *While machine dicing has been reported to be an effective method of expanding skin to close extensive defects, the modification of hand dicing does not seem to offer any advantage over sheet grafting.*

Index words: Diced skin graft, Sheet skin graft, Meshed skin graft, Skin loss, Wounds, Tissue culture.

Introduction

Skin loss occurs in many clinical situations. Such include leg ulcers, skin diseases, burns, road traffic accidents and other traumas, and surgical wounds. Although small lesions usually heal spontaneously, surgical intervention is often necessary to replace the skin in large, persistent defects[1]. However, many open wounds will heal by second intention; with contraction and epithelization[2]. Scarring is minimized and function enhanced by covering the wound with skin or a skin substitute. The major requirement of a skin substitute is that it should function as a barrier that prevents fluid and protein loss as well as bacterial invasion[2].

The conventional techniques of skin grafting comprise both epidermis and dermis. While the epidermis consists of several layers of differentiated cells, the dermis consists of collagen fibrils, fibronectin and glycosaminoglycans. These are connected together and are thought to contribute to the viscoelastic properties of skin. They are also responsible for the provision of nourishment for the cells of the epidermis through diffusion. Large surface skin loss sometimes requires skin graft expansion. Split skin grafts are most commonly expanded by meshing[3]. Meshing is achieved by increasing the distance between the strands of the mesh. However, this prolongs healing time[4]. To enhance the rate of healing, widely meshed autologous skin, up to six times, has been overlaid with allografts[5]. The width of the stands of meshed graft is based on the suggestion that fragments of skin grafts less than 1mm wide are not viable[4,6]. This limitation has been obviated by the development of a technique for generating very small fragments that retain their viability[4]. This involved dicing skin into fragments 20- 200 μm^2 using a histological tissue slicer. With this, a twenty-fold expansion of skin may be achieved without a decrease in the healing rate.

The aim of this study was to find a less expensive alternative to the histological slicer. This will make the technique of further skin expansion readily available. We initially set out with the aim of using a food chopper and blender but the inability to sterilise these instruments as well as the trauma they would produce thereby reducing cellular viability prompted the modification of the original plans.

Subjects and Methods

Twenty patients were entered into this prospective study by the convenience method of sampling between January 1997 and April 1998. They were patients who had wounds that required skin grafts for indications ranging from burns to chronic ulcer. Such were referrals to

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plastic surgery unit through surgical outpatient and casualty. The patients acted as their control. Thus each of the two methods of grafting was utilized in different parts of the body or different areas of wound in each patient.

Once the wound surface was ready for skin grafting, split thickness skin was harvested mainly from the contralateral thigh. The donor site was dressed in the conventional way with sofratulle, gauze, cotton wool and crepe. While the harvested skin was perforated to be used to cover most of the available raw surface, a small percentage was cut (diced) into tiny pieces measuring 1 x 1mm to 2 x 2mm using scalpel blade. The pieces were placed in a 50:50 concentration of saline: honey mixture. This was then applied to the remnant of the area to be grafted which in most cases measured about 30 x 30mm. No special attention was placed on the orientation of the skin pieces on the raw surface. The diced skin covered area was in turn overlaid with sofratulle.

All the sofratulle covered grafted surface then had gauze and cotton wool, with crepe bandage placed over to complete the dressing. The grafted or recipient site was viewed on day five. The percent take was noted in both sheet skin and diced skin grafted areas of the recipient site. This was taken as the percentage of the grafted surface that contained viable skin attached to the bed of the recipient skin.

Mean percent take of sheet and diced skin was noted and the median take utilizing the two methods was compared using signed rank test, level of significance was taken as $P \leq 0.05$.

Results

The 20 patients comprised 14 males and 6 females whose mean age was 32.8 $\pm$ 15.8 years. The majority, 55%, had ulcers due to trauma, 20% had wounds due to scar revision and release of contractures, 15% were cases who underwent excision of basal cell and squamous cell carcinomata while 10% had chronic ulcers. See Table 1.

Recipient sites were the thigh and leg each in five cases, upper arm in four cases, neck and forearm in three cases each, the head, chest and hand in two cases each and the foot in one case, Table 2. The mean surface grafted per case was 4.2 $\pm$ 3.0 percent of body surface. This is about four palm sizes. The donor site was the thigh in 19 cases, leg in two, scalp in two and upper arm in one.

Mean and median take of sheet skin on fifth day post operation was 96 $\pm$ 5.7% and 97.5% respectively; while of diced skin, it was 69.2 $\pm$ 31.5% and 80% respectively. The signed rank test for paired samples revealed a statistically significant difference in median percentage graft take, $P = 1.91 \times 10^{-6}$, when sheet graft was utilized compared to diced skin.

TABLE 1: *Indications for skin grafting in 20 consecutive patients in Ibadan*

Indication	n	Percentage
Trauma	11	55
Excision of scars/ contractures	4	20
Excision of tumours	3	15
Chronic ulcers	2	10

TABLE 2: *Sites grafted (Recipients sites)*

Site	n
Head and neck	5
Chest	2
Thigh	5
Leg	5
Foot	1
Upper arm	4
Forearm	3
Hand	2

Discussion

The conventional technique of skin grafting requires modification when a large raw surface is to be covered by skin. When the area of skin loss exceeds 50% of body surface area, there is insufficient donor skin to cover the wound in one operative procedure[2]. In such cases, the graft may be meshed[3], or expanded using microscopic skin grafts[7], or a small skin biopsy specimen cultured in vitro[8] with such cultured skin utilized in covering the surface[9]. In cases where sequential harvesting of the same donor site is considered, the process may not be satisfactorily rapid. Sometimes, early use of skin substitutes, synthetic or biological may obviate the threat of sepsis. However these substitutes are often temporary. The old method of postage stamp grafting has fallen into disfavour because apart from high failure rate from intervening infection, intervening hypertrophic scars may ensue constituting poor cosmetic outcome.

Skin graft expansion by machine meshing was first described by Tanner et al[3] in 1964. The expansion of the mesh, which produces a wider base for reepithelization, and the healing of interstices by second intention are the basis for this technique when used on a large major wound as is sometimes the case in burns. Meshed grafts combine the advantage of allowing adequate drainage of haematoma, seroma or discharge in the vital early period after graft application. It produces a 'three dimensional' flexibility[10] for conformity and adequate application to

the recipient bed. The expanded meshed skin graft however is criticised because of the poor appearance of the residual mesh pattern it produces. Matsuzaki et al[11] reported an improvement in the disfigurement of meshed skin graft scars which they resurfaced with autologous cultured epithelium after excising. However, the skin graft mesher is still not available in most centres in developing countries.

The technique of tissue culture involves in vitro cultivation and passaging of single cell suspensions of keratinocytes to produce epithelial sheets[12]. The skin biopsy is enzymatically digested by trypsin to produce a suspension of keratinocytes which is grown on a monolayer of irradiated mouse fibroblast feeder cells. They are grown in culture flasks which contain a medium of serum and mitogens namely epithelial growth factor and cholera toxin. The epidermal cells are then detached from the plastic flask using dispase and are transferred as grafts on a nonadherent dressing[1].

A disadvantage of keratinocyte transfer is the delay necessary for the expansion to be achieved. Poor take is typical in the presence of infection and topical antiseptic use is contraindicated because most of them have been shown to be toxic to the culture cells even at low concentration. Wound contraction has been shown to be slightly greater than in split skin grafted wounds when used after excision of giant naevi[13]. The major disadvantage of the use of tissue culture is limited availability particularly in developing countries.

Stretching skin further than the expansion obtained with graft mesher has been achieved using a food chopper and blender in animal experiment[6] and in the use of microscopic skin graft[4] obtained from histological slicer. In the experiment that utilized the histological slicer, no attempt was made to achieve correct orientation of the diced skin fragments. Skin used in our experiment was hand diced because we did not have a histological slicer. Similarly no attempt was made to achieve orientation of the diced skin fragments. The graft take is gratifying though significantly less than the take when sheet graft was used. This might be partly explained by the fact that no attempt was made to achieve correct orientation of the skin fragments. Graft take after diced skin grafting is difficult to assess because the wound tends to be translucent initially. A follow up study to assess appearance, thickness, durability, and texture as well as histological view of the microstructure of the healed area is pertinent.

It will be difficult at this stage to define the role of honey in reepithelization at the edges of diced skin and in enhancing graft take. Mention has been made previously[14] of the protection against infection afforded by honey on skin grafts and donor sites. The enhancing effect, if there is any, of honey will be expected to be indirect through limiting infection which would in turn reduce the chances of graft take.

While Nanchahal[4] reported complete re-epithelization within one week in 86% of cases using diced skin expanded to 4 – 20x, we did not achieve complete re-epithelization in any of our cases within the same period. This suggests that greater benefit is derived from dicing with histological slicer than with scalpel blade.

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