WOUND CONTRACTION IN RABBITS AND THE EFFECTIVENESS OF SKIN GRAFTS IN PREVENTING IT

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FULL thickness cutaneous wounds in mammals heal by contraction (Billingham and Reynolds, 1952; Billingham and Medawar, 1955) with varying degrees of success depending upon their anatomical location, the tissues involved and the species of animal. It is well recognised that contraction may be prevented by covering the wound with a skin graft, thicker grafts being more effective than thinner ones (Brown and McDowell, 1958; Fomon, 1960). Padgett (1942) observed that whereas a thin graft on the neck may contract by 60 per cent, a thick graft contracts by only 10 to 30 per cent, while with full thickness grafts, contraction is negligible. Billingham and Russel (1956) went further and stated that coverage of a fresh as well as a granulating and actively contracting full thickness cutaneous wound with a full thickness skin graft completely inhibits contraction, whereas thin grafts are almost ineffective in retarding contraction. In fact, we have been unable to trace any controlled study on the role of skin grafting in preventing wound contraction.

In view of the paucity of work on this aspect of wound healing, a detailed study has been undertaken (1) to elucidate the effectiveness of skin grafts in preventing wound contraction and (2) the difference in the effectiveness of skin grafts of varying thickness, and (3) to estimate the degree to which the contraction of a wound is retarded by coverage with grafts should they be effective in doing so.

Method and Material.—The study was conducted in rabbits in whom the healing of small sized cutaneous wounds is generally completed by contraction alone. There were two groups of 15 rabbits each.

Group A. The 15 rabbits were divided into three sub-groups of five animals each. In the first sub-group, full thickness cutaneous wounds were created after excision of a 2×2 cm. area of skin and dressed with Vaseline gauze. Wounds were exposed daily and measurements of size recorded accurately. This was continued till the wound had completely contracted. The time taken by a wound to contract fully served as a control. In the second group, wounds were covered with full thickness skin grafts of the same size as the wound and in the third group wounds were immediately covered with split skin grafts taken from the ventral surface of the body with a Humby knife.

Group B. The experiments in this group were conducted on exactly the same pattern as in Group A, except that the wound size was 3×3 cm.

It may be mentioned that because of the difficulty of management of grafts in rabbits, there was a high percentage of graft failure, partial or complete. Only those experiments were included in the study in which grafts had taken completely.

After initial skin preparation, the animals were premedicated with intramuscular atropine, 0.04 mg. per kg. body weight, half an hour before the experiment. Pentothal sodium, 26 mg. per kg. body weight was administered intraperitoneally as an anaesthetic agent and supplemented by open ether when necessary. Wounds were created on the side of the body mid-way between dorsal and ventral surfaces and between the fore and hind limbs.

A tracing of the wound was taken on sterile cellophane paper and the surface area expressed in mm. determined by using a planimeter. In the case of partial and full thickness skin grafts, the first measurement was taken at the time of applying the grafts. Subsequent measurements were taken after the complete take of the graft was ensured, *i.e.*, generally 7 to 10 days. The results were expressed as rates of contraction per unit area and percentage contraction obtained from the following formulae :—

$$\text{Rates of contraction } (r) \text{ over a period } (x) \text{ per unit area.} = \frac{\text{Decrease in wound area in } (x) \text{ period}}{\text{Initial wound area}}$$

$$\text{Rates of contraction per unit area per day.} = \frac{\text{Decrease in wound area}}{\text{Initial wound area} \times \text{No. of days.}}$$

$$\text{Percentage contraction} = \frac{\text{Decrease in wound area in whole period}}{\text{Initial wound area}} \times 100.$$

Observations.—*Open wounds* 2×2 *cm.*—Immediately after wounding the size increases, but contraction starts soon afterwards ; the maximum contraction occurs in the first 13 days when the wound has contracted by 79·3 per cent. The wound is fully contracted by the twenty-fifth day on average. The rates of contraction per unit area per day progressively decrease as the contraction proceeds, being highest immediately after wounding, *i.e.*, 0·094 in the first five days and lowest in the terminal phase, *i.e.*, 0·011 between the twenty-first and twenty-fifth days. The differences in rates are significant ($p < 0·05$).

Wounds 2×2 *cm. covered with split skin grafts.*—Contraction of the wounds becomes apparent after graft take is assured, *i.e.*, after five days, and maximum contraction occurs in the first 17 days, at the end of which the wound has contracted by 55·3 per cent. The contraction is complete in 29 days when the wound has contracted by 69·6 per cent. The rate of contraction is highest between five and nine days (soon after graft take) being 0·050 and then decreases progressively. It is lowest in the last phase of contraction, being reduced to 0·003. The differences in rates of contraction between the fifth and ninth days, and thirteenth and seventeenth days are significant ($p < 0·01$), as is also the difference in rates between the thirteenth and seventeenth days and the twenty-first and twenty-fifth days, ($p < 0·001$).

Wounds 2×2 *cm. covered with full thickness grafts.*—Wounds keep contracting under full thickness skin grafts and the maximum contraction occurs by the thirteenth day, by which time the wound has contracted by 35·2 per cent. Thereafter the progress of contraction is slowed until it is complete by the thirty-third day when the wound has contracted by 44·9 per cent. The rates of contraction per day are highest immediately after coverage and after the graft take is assured, *i.e.*, during the first nine days, being 0·031 and 0·033 in the first five days and between the fifth and ninth days respectively. Following this, the rates of contraction are reduced until the last phases of contraction between the twenty-fifth and twenty-ninth days when they are lowest, being 0·005. The differences in rates of contraction between different periods, *i.e.*, fifth to ninth day and thirteenth to seventeenth day, and thirteenth to seventeenth day and twenty-first to twenty-fifth day are significant ($p < 0·001$).

It was observed that the behaviour of the 3×3 cm. wounds did not differ significantly from that of the smaller wounds whether left open or covered with partial or full thickness skin grafts ($p > 0·05$).

Comments.—It is apparent that open wounds in rabbits of the sizes used heal completely by contraction alone. Contraction starts early and the rates of contraction are highest immediately following wounding ; thereafter they are progressively reduced until the wound is fully contracted.

Covering with skin grafts whether partial or full thickness does not completely inhibit contraction. The wounds continue to contract under the grafts although the process of contraction is retarded and partially inhibited. The thickness of the graft is certainly an important factor influencing the contraction so that, whereas under split skin grafts wounds contracted by 69·9 per cent, the full thickness graft covered wounds contracted by 44·9 per cent only (Fig. 1). The difference is highly significant ($p < 0.01$).

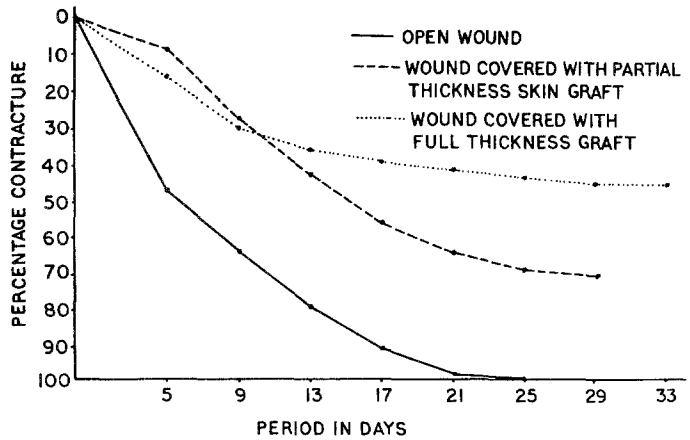

FIG. 1

Graph showing comparison of contraction of the wounds left open or covered with partial or full thickness skin grafts.

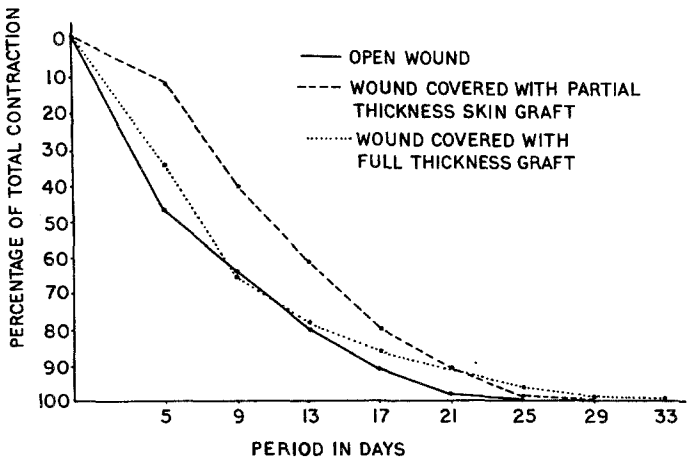

FIG. 2

Graph showing comparison of the total contraction in relation to the period of observation in wounds left open or covered with partial or full thickness skin grafts.

The progress of contraction is also slowed so that while open wounds are fully contracted in 23·2 days on average, maximum contraction takes place after 29 days in wounds covered with partial thickness skin grafts and after 33 days in wounds covered with full thickness skin grafts, so that the thicker the graft, the longer the period through which contraction occurs.

Another important finding is that maximum contraction takes place in the initial period of 13 to 17 days after wounding irrespective of whether the wound is left open or is covered with skin grafts (Fig. 2).

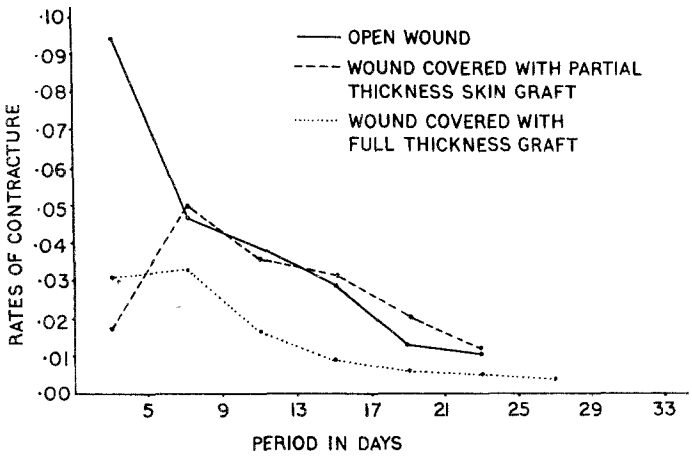

FIG. 3

Graph showing comparison of the rates of contraction per unit area per day over the period of observation in wounds left open or covered with partial or full thickness skin grafts.

The rates of contraction over different periods are comparable in wounds left open or covered with partial thickness skin grafts (Fig. 3) and the differences are not significant ($p > 0.05$), but the rates differ significantly from wounds covered with full thickness skin grafts over all periods ($p < 0.01$). In the latter case, the rates of contraction are lowest. The only exception is in the first five days of wounds covered with full thickness grafts. This is explained by the fact that full thickness grafts have not taken fully in this period and are as yet not effective in preventing contraction.

SUMMARY AND CONCLUSIONS

1. The role of skin grafts, partial and full thickness, in preventing wound contraction has been studied experimentally under controlled conditions in 30 rabbits.

2. It is concluded that wounds keep on contracting even when covered with skin grafts irrespective of their thickness.

3. Wounds covered with split skin grafts contract by 69·9 per cent, whereas those covered with full thickness grafts, contract by 44·9 per cent only.

4. The process of contraction is delayed by covering with grafts and full thickness grafts delay it more than partial thickness grafts.

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