PRINCIPLES GOVERNING HEALING OF EXTENSIVE SKIN DEFECTS IN RABBITS

E. A. Efimov

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The closure of extensive skin defects in the dorsal region of rabbits takes place mainly by contraction of the wound. As the result of healing a small scar is formed, which is not converted into normal skin.

Most investigators consider that as a result of healing of full-thickness skin defects, in cases when the skin possesses adequate mobility, a small connective-tissue scar is formed. This scar is not converted into normal skin [6,12].

In earlier investigations [3-5] the author showed that in mice and rats a scar is formed as the result of healing of full-thickness skin wounds in the dorsal region, which is not converted into skin. Closure of the defect involves the participation of an area of corium lying next to the wound, which moves into the upper peripheral layers of the defect. Hairs and sebaceous glands are formed from ingrowths of the epithelium covering it. The development of the specific structures of the skin (hair and glands) from ingrowths of the epithelium into the young connective tissue filling the central part of the defect could not be observed.

However, some workers hold the view that the scar formed as a result of healing of full-thickness skin wounds is converted as a rule into skin, with the formation of hair and glands [1,2,8,9,11]. It is important to note that many of the investigations of scar reorganization have been carried out on rabbits [2,9, 11]. Some workers, in particular, observed the formation of hair in rabbits over the entire epithelized surface of the defect [7,10].

These observations suggest that regeneration of the skin in rabbits exhibits certain special features.

The object of this investigation was to study the healing of skin wounds in rabbits.

EXPERIMENTAL METHOD

Experiments were carried out on 21 male gray rabbits: 11 animals weighing 1.5-2 kg (age group 1) and 10 rabbits weighing 3-4 kg (age group 2). The hair was plucked from the skin of all the animals in the middle part of the dorsal region, after which a full-thickness skin graft measuring 7 × 7 cm was removed (down to the subcutaneous cellular tissue in 5 animals of group 1 and 6 animals of group 2, down to the fascia in the rest).

Ink marks were applied to all the rabbits at a distance of 1-2 mm from the wound edge. The marks were made all around the defect. The ink was injected into the skin by two soldered sewing needles, which were inserted into a Frank's needle instead of the stilet. The area of the wound, followed by the area of the epithelized surfaces of the defect, was measured at successive stages of healing. Pieces of tissue were taken for histological analysis from the region of the wound and adjacent areas of intact skin 20 days and 1, 2, 3.5, 5, 8, and 10 months after the operation. They were fixed in 12% formalin, taken through celloidin, and embedded in paraffin wax. Histological sections cut to a thickness of 7-12 μ were stained with hematoxylin-eosin and orcein.

EXPERIMENTAL RESULTS

Healing of the wound took place beneath a scab. In the early stages of healing (7th-12th day after the operation) delay in contraction of the wound was observed in animals from which the skin was taken down

Laboratory of Growth and Development, Institute of Experimental Biology, Academy of Medical Sciences of the USSR, Moscow (Presented by Academician of the AMN SSSR A. P. Avtsyn). Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 67, No. 2, pp. 97-100, February, 1969. Original article submitted May 23, 1968.

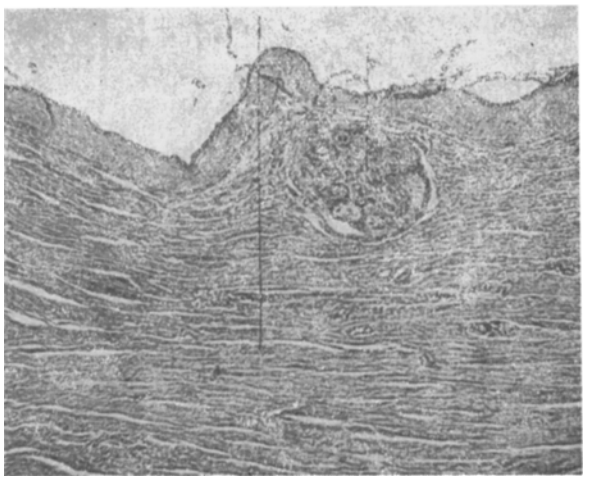

Fig. 1. Sections through rabbit's skin in the central part of the wound defect 10 months after operation. 1) Scar tissue; 2) skin complex. Fixed with formalin and stained with hematoxylin-eosin, 90 ×.

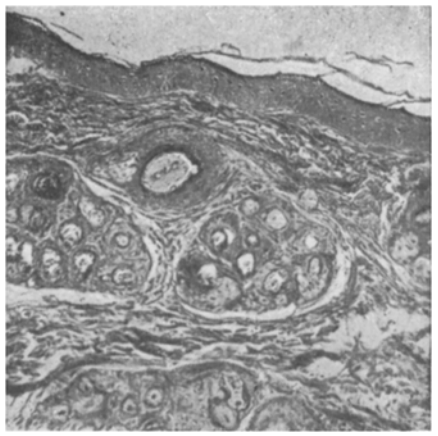

Fig. 2. Section through normal skin from the dorsum of a control rabbit. Formalin. Hematoxylin-eosin, 90 ×.

to the fascia compared with animals from which the graft was cut down to the subcutaneous cellular tissue. However, complete epithelization of the wound surface occurred in all animals on the 34th-40th day after operation. In the animals of group 1 at this period the area of the epithelized surface of the defect was 7-9% of the total area of skin removed, while in the animals of group 2 it was 23-27%, i.e., the decrease in the area of the wound was delayed in the older animals. In all the animals the ink marks lay at a distance of 2-4 mm from the edge of the epithelized surface of the defect. The increase in distance between the marks and edges of the defect was due to intervening growth outside the wound affecting the skin immediately adjacent to the wound.

Subsequently in the animals of group 1 the area of the epithelized surface of the defect was practically unchanged. In the peripheral part of the epithelized surface and, in 4 rabbits, in the central part also, thin hairs were found 1.5 months after operation.

In the animals of group 2, the area of the epithelized surface was smaller, and by the end of the 3rd month it amounted to 8-11% of the total area of skin removed. In some parts of the epithelized surface of the defect in these animals, thin hairs could be seen. The ink marks lay at a distance of 3-5 mm from the edge of the epithelized surface. Subsequently the area of the epithelized surface in the rabbits of group 2 remained unchanged.

After the end of healing in the rabbits of group 1, the long axis passing through the epithelized surface of the defect lay parallel to the long axis of the animal's trunk, while in the animals of group 2 it lay perpendicular.

Histological observations showed that 20 days and 1 month after operation, the upper layers of the peripheral part of the defect in all the animals consisted of a small wedge of intact corium which had migrated there. The elastic fibers of the wedge of corium at this stage, and also at all subsequent stages, passed without a clearly defined border into the network of elastic fibers of the intact corium lying next to the wound.

The remaining areas of the defect were filled with young connective tissue, which became converted into a scar 2 months after operation in the animals of group 1 and 3.5 months after operation in those of group 2.

The hairs found in the central part of the epithelized surface of the defect evidently arose from ingrowths of the epithelium covering the wound into the subjacent young connective tissue. These ingrowths were observed before transformation of the young connective tissue into the scar. In their structure, these ingrowths resembled the early stages of hair development.

After the end of healing, the peripheral part of the defect consisted of a small area of the corium next to the wound which had migrated into the zone of the defect. The central part of the defect was occupied by a scar, and here and there in its upper layer, immediately beneath the epithelium, groups of hair follicles

and sebaceous glands could be seen, frequently forming "skin complexes" (Fig. 1). Later (5, 8, and 10 months after operation) no essential changes took place in the morphological structure of the tissues filling the defect.

Hence, closure of extensive skin defects in rabbits takes place principally through contraction of the wound. The contraction process in the animals of group 2 continued for a long time after complete epithelization of the surface of the defect. The small scar formed in all cases was not converted into normal skin. Specific skin structures (hair and glands) found in some areas of the scar were formed from ingrowths of the epithelium into the young connective tissue before its transformation into a scar. They differed in size, depth, and number per unit of surface from the specific structures of normal skin in the same area (Fig. 2). Consequently, complete regeneration of the skin does not take place in rabbits in the course of a long period of observation.

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