COMPARISON OF HEALING OF FULL-THICKNESS WOUNDS IN NEWBORN AND SEXUALLY MATURE RATS

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Healing of wounds was investigated in sexually mature and newborn rats after removal of a full-thickness skin graft from the dorsal region area of graft approximately 8% of total skin area of animal). Healing of the wound took place in the young rats 10-12 times faster than in the sexually mature rats. In the young rats the connective-tissue scar formed at the site of the defect had a mean area of 8% of the area of removed skin compared with 42% in the adult rats.

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It is generally considered that healing of full-thickness skin wounds concludes by formation of a connective tissue scar, not subsequently transformed into normal skin. Contrary to this view, some workers consider that reorganization of the connective-tissue scar into normal skin can take place regularly with the formation of specific skin structures (hair and glands) [1, 2, 6-8]. However, detailed investigations in this direction have been performed only on young animals [1, 2]. For instance, in an investigation conducted on newborn rats from which a full-thickness skin graft 1 cm^2 in area was removed, V. V. Glinchikov [2] describes how careful histological analysis revealed that the scar in animals of this age acquired the characteristic structure of skin with the development of specific structures (hair and glands). This worker observed the course of healing of full-thickness skin wounds in newborn animals at successive times until one month.

In my own investigations [3, 4] on sexually mature rats and mice from which full-thickness skin grafts of different sizes had been removed in every case I observed the formation of a connective-tissue scar which did not subsequently undergo conversion into normal skin.

In the present investigation the course and outcome of skin regeneration were studied and compared in newborn and sexually mature rats.

EXPERIMENTAL METHOD

Noninbred male albino rats weighing 150-180 g and newborn noninbred albino rats weighing 5-6 g (22 adult and 40 newborn animals) were used in the experiments. From the middle part of the back rectangular full-thickness skin grafts measuring from 22.4 to 25 cm^2 in area were removed from the rats down to the fascia, and square full-thickness skin grafts measuring from 0.98 to 1.4 cm^2 were removed from the young rats. The area of the skin graft removed from the adult and young rats was approximately the same when expressed as a ratio of the total skin area: 8.9% for the adults and 7-8% for the young rats. For this reason the pattern of healing of equivalent wounds could be compared in the animals of these two groups.

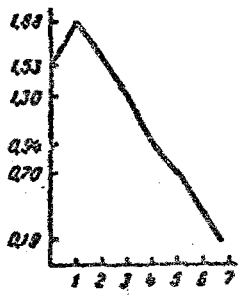

Fig. 1. Graph of contraction of wounds in newborn rats. Abscissa, time after operation (in days); ordinate, area of wound (in cm^2).

Before the operation ink lines were drawn on all the animals around the future defect and 1-2 mm away from the edge of the wound. The area of the wounds was measured at successive periods during healing. Also at successive periods pieces of tissue were excised from the region of the

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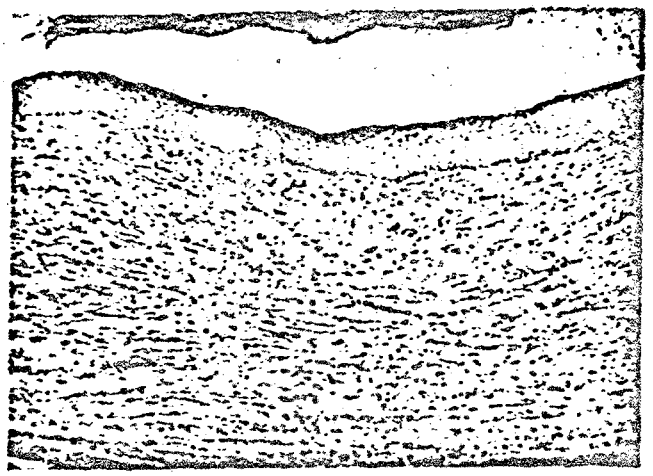

Fig. 2. Vertical section through central part of wound defect in newborn rat 75 days after operation. Photomicrograph, 90×. Hematoxylin-eosin.

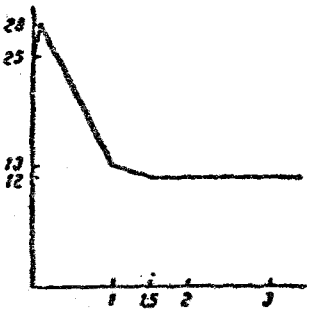

Fig. 3. Graph showing contraction of wounds in sexually mature rats. Abscissa, time after operation (in months); ordinate, area of wound (in cm^2).

wound and adjacent skin areas for histological analysis. The material was fixed in 12% formalin, taken through celloidin, and embedded in paraffin wax. The thickness of the section was 7-10μ and they were stained with hematoxylin-eosin.

EXPERIMENTAL RESULTS

The experimental results showed that healing of full-thickness skin wounds in newborn and sexually mature rats shows certain essential differences. In the newborn animals, for instance, contraction of the wound in the main period of healing was expressed graphically by an almost straight line (Fig. 1). Healing of the wound took place under a scab. By the 9th-10th day after the operation the central part of the defect was filled by a connective-tissue scar. Its area averaged 8% of the area of the removed skin graft. The histological structure of the scars was studied on the 30th and 75th days after operation. Reorganization of the scar into normal skin could not be observed. The scar consisted of horizontally arranged bundles of collagen fibers and fibroblasts. Blood vessels mainly running in a vertical direction could be seen. The scar was covered by epithelium which did not form protrusions into the subjacent tissue (Fig. 2).

In the sexually mature rats healing of the wounds took place under a thick scab. Closure of the defect took place extremely slowly: 1.5 months after operation the area of the wound had diminished by approximately one-third (Fig. 3). The wound defect was not completely epithelized until 3.5-4 months after the operation. In the central part of the defect an extensive scar had formed, its area (10-12 cm^2) averaging 42% of the area of the excised skin graft. The scar was elongated in shape, its long axis coinciding with the long axis of the trunk. The length of the scar was 3-3.5 times greater than its width.

In the young rats the longitudinal and transverse axes of the developing scar were approximately equal. In the sexually mature rats the epithelized surface of the defect lay inside the ink lines, which were 4-5 mm away from its edges. The zone between the edges of the epithelized wound surface and the ink lines was covered with hair. In the peripheral part of the epithelized wound surface isolated thin hairs were found for a distance of 1-2 mm from its edge. The ink lines on the young rats were only slightly displaced relative to their initial position toward the defect and the extensive zone between the lines and the epithelized surface of defect was occupied by "old" skin. Difference in the behavior of ink lines in sexually mature and newborn rats were described in a special paper [3].

In young rats, and also in adult rats, hairs and sebaceous glands were found in the peripheral part of the epithelized surface of the wound defect. These specific skin structures evidently develop in animals

from protrusions of the epithelium covering the area of the corium lying next to the wound, which was displaced into the uppermost peripheral layers of the wound defect on account of the drawing together of its edges and interposed growth [3, 4].

Healing of skin wounds in sexually mature and newborn rats following excision of full-thickness skin grafts whose area is approximately the same in the animals of these two groups when expressed as a percentage of the total skin area of the body thus shows essential differences. Covering of the wounds in young rats, for instance, finishes 10-12 times faster than in sexually mature rats. As a result of healing a connective-tissue scar is formed in all the experimental animals. In the young rats its area averages 8%, and in the sexually mature rats 42%, of the area of the excised skin graft. The formed scars in both the young rats and adults are not converted into normal skin with hairs and glands in the course of a long period of observation either in the young rats or in the sexually mature animals.

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