HEALING OF SKIN WOUNDS IN BIRDS

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UDC 617-001.4-036.864:[619:636.5

Healing of full-thickness skin defects in cocks is characterized by rapid contraction of the wound followed by a gradual increase in the area of the epithelized surface of the defect. The regenerating skin, possessing folds characteristic of birds' skin, differs from the normal in the denser arrangement of its fibers and, in most cases, by the absence of feathers.

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In contrast to the many investigations of healing of skin wounds in mammals, very few studies have been made of the healing of skin wounds in birds. Regeneration of the skin in birds has been described most fully by Brown [1, 2] and Raivid [3, 4]. They consider that in birds, just as in mammals, as a result of healing of full-thickness skin wounds a scar is formed, which is subsequently converted into skin having the typical structure of the particular part of the animal's body. However, these workers did not give a detailed histological analysis of successive changes of skin regeneration, nor could they detect any essential features distinquishing the course of regeneration in birds.

The object of this investigation was to study healing of full-thickness skin wounds in birds at different stages of repair.

EXPERIMENTAL METHOD

Experiments were carried out on 32 cocks weighing 0.6-0.8 kg of the White Leghorn breed. Pieces of skin measuring 2 × 2 cm were removed in full thickness from beneath the base of the right and left wings of 18 cocks. Wounds of the same size were produced on the left and right sides of 14 cocks. The edges of the wound in all animals were marked with ink. The ink was injected into the dermis by means of a Frank's needle the stilet of which was replaced by two suturing needles folded together. The ink marks were placed

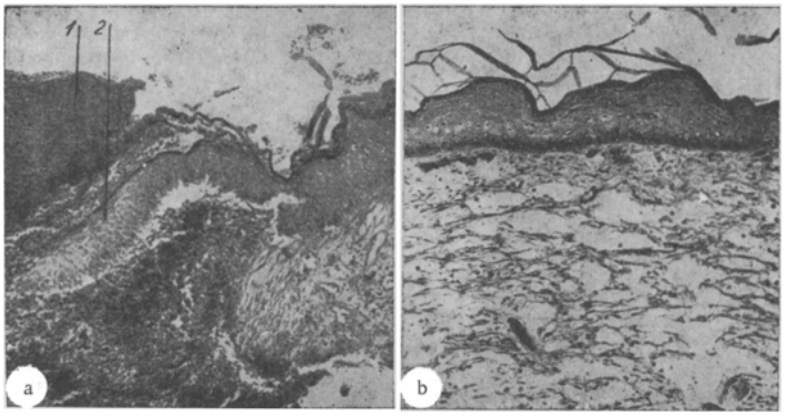

Fig. 1. Vertical sections through cock's skin in region of wound in early stages of healing. a) Fourteen days after operation; 1) scab; 2) edge of epithelial layer; b) 21 days after operation. Photomicrograph. Formalin, hematoxylin-eosin, 90×.

Laboratory of Growth and Development, Institute of Experimental Biology, Academy of Medical Sciences of the USSR, Moscow. (Presented by Academician of the Academy of Medical Sciences of the USSR N. A. Kraevskii.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 68, No. 8, pp. 102-105, August, 1969. Original article submitted October 6, 1968.

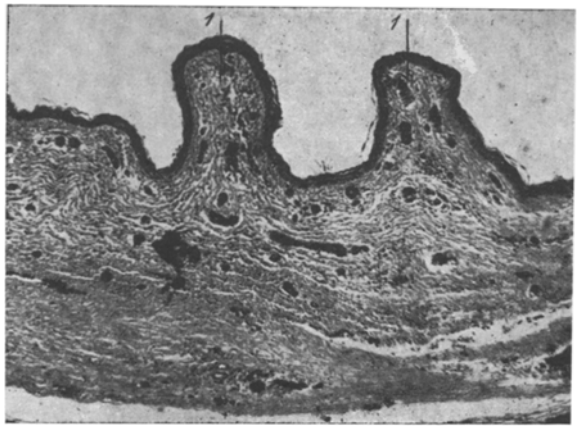

Fig. 2. Vertical section through cock's skin in region of wound defect 32 days after operation. 1) Fold of regenerating skin. Photomicrograph. Formalin, hematoxylin-eosin, 90×.

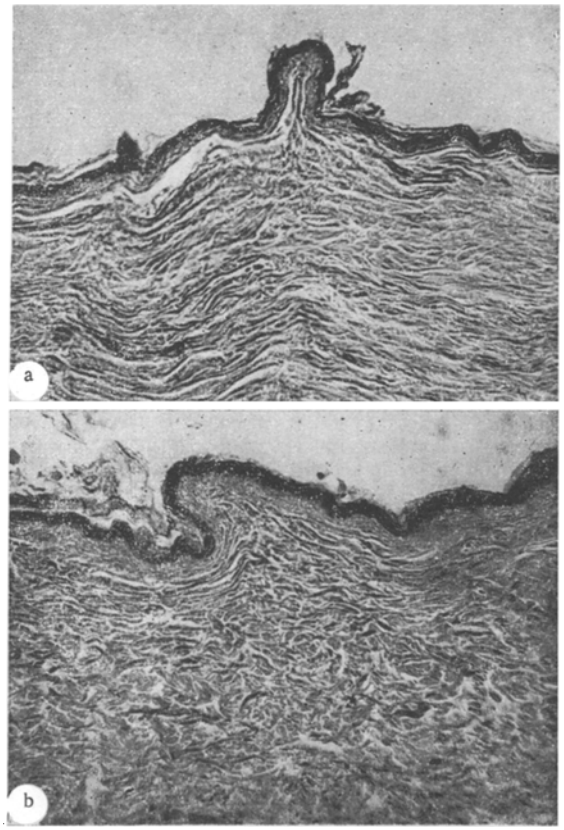

Fig. 3. Comparative vertical sections through normal and regenerating skin of cocks of the same age. a) Regenerating skin 8 months after operation, formed at site of defect beneath wing; b) normal skin beneath wing. Photomicrographs. Formalin, hematoxylin-eosin, 90×.

0.5-1 mm externally to the wound margin. Specimens were taken from region of the defect and the adjacent areas of intact skin 14, 21, 28, and 32 days and 1.5, 3, and 8 months after the operation for histological analysis.

The material was fixed in 12% formalin solution, taken through celloidin, and embedded in paraffin wax. Histological sections 7-10 μ thick were stained with hematoxylin-eosin.

EXPERIMENTAL RESULTS

Healing of the wound took place under a scab. Soon after the operation the mean area of the wound under the wing was 4.3 cm^2, and on the side 4.7 cm^2. By the 7th day after the operation the wounds had contracted: their mean area under the wing was 3.1 cm^2 and on the side 3.6 cm^2. By the 14th day the mean area of the wound under the wing was 1.2 cm^2, i.e., 29% of the initial area of the defect, and on the side 1.9 cm^2 (40%).

Epithelization of the wound under the wing was complete on the 20th-23rd day, and on the side on the 22nd-24th day after operation. By this time the area of the defect under the wing was 6-8% of the area of skin removed, and on the side it was 24-28%. The area of the defect was unchanged on the 28th and 35th days after operation.

Later (1.5 months after operation) the area of the epithelized surface of the defect unexpectedly began to increase, and after 3 months it was 55% of the area of skin removed under the wing and 46% on the side. The ink marks were 1-2 mm away from the edge of the epithelized surface of the defect.

Visual inspection of the epithelized surface of the defect showed well-marked folds and areas between them. These structures are typical of normal birds' skin [5].

Histological examination showed that 14 days after the operation the greater part of the wound was occupied by young connective-tissue (granulation tissue). The epithelium growing over its surface was 12 times thicker than intact (mean thickness of growing epithelium 210 μ, of intact epithelium 17 μ). The edge of the epithelial layer was insinuating itself beneath the scab as a pointed wedge (Fig. 1a). The whole defect 21 days after the operation was filled with young connective tissue, composed principally of cells which were loosely arranged in the center (Fig. 1b); its mean thickness was 1800 μ, three times thicker than the intact corium. The epithelium was hypertrophied: its mean thickness was 110 μ, 5 times thicker than the intact epithelium.

The young connective tissue filling the defect 28 and 32 days after the operation consisted of thin fibers and cells: numerous blood vessels were contained in it. The thickness of the epithelium was much less than at the preceding stage, and was equal to that of intact epithelium (18 μ).

The regenerating skin formed at the site of the defect 32 days and 1.5 and 3 months after the operation had typical folds of normal skin of birds of the same age (Fig. 2).

Fibrous structures in the folds, just as in normal birds, were more loosely arranged than in areas where the surface of the regenerating skin was smooth.

The thickness of the regenerating skin 1.5 and 3 months after the operation was much less than that of intact skin. For instance, 3 months after the operation the thickness of the regenerating skin under the wing averaged 250 μ, compared with 720 μ for intact skin; the thickness of the regenerating skin of the side was 360 μ, compared with 1200 μ for intact skin.

Eight months after the operation the regenerating skin consisted largely of coarse bundles of fibers and formed small folds which were flatter than at the preceding period. Solitary feathers were found in the regenerating skin beneath the wing in three animals and on the side in four animals, but their origin could not be determined.

The structure of the regenerating skin was similar to that of normal skin in animals of the same age. However, fibrous structures in the regenerating skin were more compactly arranged than in the control, and were mainly oriented parallel to the skin surface (Fig. 3a, b). The thickness of the regenerating skin was similar to that of normal skin of control animals.

Closure of the defect in cocks thus took place principally by contraction of the wound. At the time of complete epithelization of the defect the wound was filled with young connective (granulation) tissue, several times thicker than the normal corium.

The epithelium covering the wound was hypertrophied. Subsequently, the thickness of the young connective tissue filling the defect decreased and it was gradually transformed into regenerating skin whose area increased over a long period of observation. In contrast to the healing of skin wounds on the trunk in mammals and birds, no scar formed. The structure of the regenerating skin was similar to that of the skin of normal animals, although the fibrous structures in it were more compactly arranged and no feathers developed on it in most cases.

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