COMPARISON OF REGENERATION OF THE CONCHA AURICULAE OF THE RABBIT AFTER EXPOSURE TO PULSED AND CONTINUOUS-ACTION LASER BEAM

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After exposure of the rabbit concha auriculae to a pulsed-action neodymium laser destruction of the tissues and the formation of perforating wounds were observed. Regeneration followed, with disappearance of the small defects and a decrease in size of the large. In experiments with a continuous-action CO_2 laser incomplete regeneration of the damaged tissues took place.

No information on regeneration of the tissues of the concha auriculae after exposure to pulsed and continuous-action lasers could be found in the accessible literature.

The object of this investigation was to study the course of regeneration of the rabbit concha auriculae after exposure to a laser beam.

EXPERIMENTAL METHOD

A continuous-action CO_2 laser (40 W, wavelength 10.6 μ) was used. The diameter of the focused beam was 2 mm, the exposure 2 sec, energy 80 J, and energy density 1126 J/cm^2. A pulsed-action OKG-500 neodymium laser with wavelength 1.06 μ also was used. The beam was defocused, 5 mm in diameter, and the area of the light spot was 0.196 cm^2. The exposure was 0.003 sec, energy 475 J, and energy density 6607 J/cm^2.

The conchae auriculae of a gray chinchilla rabbit were used as the experimental model. The laser beam was applied to one side of the concha auriculae. Altogether 247 experiments were carried out, and regeneration was studied for between 40 and 182 days. Celloidin sections, 15-20 μ thick, were stained with hematoxylin-eosin and with picrofuchsin by Van Gieson's method.

EXPERIMENTAL RESULTS

After exposure of the concha auriculae to the continuous-action laser, defects were formed consisting of grooves or perforating wounds. After 24 h the defects were covered with a dry brown scab. By the 5th-15th day, depending on the depth of the lesion, the scabs separated to form a delicate pale pink scar. After 30-45 days the scar was the same color as the surrounding tissues and was less clearly visible. A tendency was observed for the perforating wounds to increase in size from the 7th to the 15th day, and this was accompanied by the formation of necrotic masses at the periphery of the perforating wound, followed by sloughing. Peripheral regeneration of the perforating wounds took place by the 20th-30th day.

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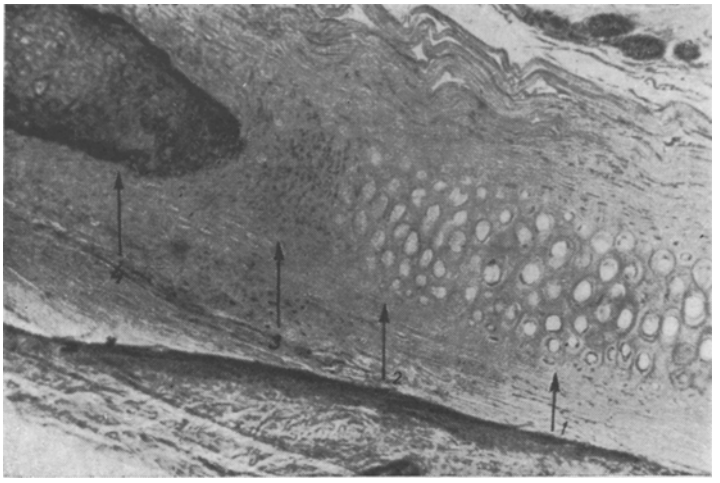

Fig. 1. Regeneration of cartilaginous plate after exposure of concha auriculae of a rabbit to a pulsed-action laser: 1) old cartilage; 2) intermediate zone; 3) newly formed cartilage; 4) sequestrum in cartilaginous tissue.

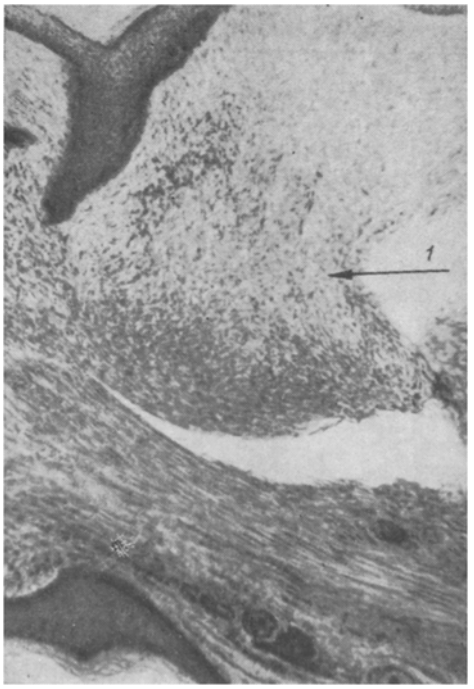

Fig. 2. Regeneration of tissues of rabbit concha auriculae after exposure to continuous-action laser: 1) defect replaced by scar tissue.

After exposure of the concha auriculae to a pulsed-action neodymium laser defects which macroscopically resembled spots were formed. The spots were either homogenous or the tissues were damaged to different depths. The color of the defects changed in the course of 2 days from whitish to brown. Condensation and a decrease in thickness of the tissue were observed in the region of the spot. Sloughing of the central portion with the formation of a perforating wound was observed on the 15th-20th day in the defects with lesions of different depths. If the perforating wound had a diameter of 1-2 mm, after 40-50 days it was closed by newly formed tissue. If the diameter of the perforating wound was 5 mm, it was reduced in size but still remained unclosed from 90 to 270 days later. The defects consisting of homogeneous spots gradually disappeared, and after 50 days it was impossible to detect macroscopically where the injury had been.

The histological study of regeneration showed that after exposure of the tissues of the concha auriculae to a pulsed-action neodymium laser the normal structure of the epidermis and dermis was restored after 182 days. Reconstruction of the cartilaginous plate is noteworthy. Three zones were clearly defined: a zone of normal structure of the cartilage, followed by an intermediate zone characterized by tissue degeneration, and a zone of newly formed cartilage. The intermediate zone consisted of areas of necrotic cartilage, which appeared in sections as round shadows of cartilaginous cells between which there was very little weakly basophilic ground substance. The zone of newly formed cartilage contained fibrous tissue, the fibers of which were arranged longitudinally just as in the perichondrium. Among the fibers there were small fragments of cartilage separated by thin fibrous bands running in a direction perpendicular to the axis of the perichondrium. In some places sequestra of cartilage tissue could be seen; their borders were permeated with protein (fibrin) and showed decalcification. Some of the sequestra underwent lacunar resorption (Fig. 1).

During regeneration of the tissues of the rabbit concha auriculae 40 days after exposure to a continuous-action CO_2 laser, considerable thickening of the epithelium to 10-12 layers on account of marked hyper-

keratosis could be seen in the zone of the former epicenter. The defect in the connective-tissue dermis was replaced by young fibrous tissue consisting of bundle-like structures with few fibers and rich in fibroblasts. In the zone of the replaced defect there were more hair bulbs than in the adjacent areas. The dermis in areas adjacent to the future epicenter were thickened and hyalinized, increasing its density, and contained coarse fibers. The cartilage plate did not regenerate in the epicenter but lost its structure and was replaced by cartilage tissue. Young connective tissue with a strongly basophilic stroma, in which there were numerous histiocyte-like cells, was formed between the end of the cartilaginous plate and the scar tissue. Vessels of arterial and venous type could be traced in the dermis and were indistinguishable from normal. Later (105 days) several cartilaginous plates arranged like tiles in 2 or 3 layers were noticeable. Among the cartilaginous plates there were remnants of old cartilage and plates of newly formed cartilage, a product of proliferation of the perichondrium. The newly formed cartilaginous plates were 2-3 times thicker than the old cartilage. Regeneration of the defect took place on account of proliferation of the perichondrium, which evidently forms fibrous tissue superficially and subdermally, while in the deeper portions it forms layers of cartilage tissue. Maturation of the cartilaginous tissue took place multicentrically and asynchronously. A short distance from the former defect the cartilaginous tissue formed a sequestrum, evidently through the action of the reflected beam. The epithelium was thicker on the side of the former epicenter and contained up to 15-20 layers of cells. On the side opposite to the action of the laser the basal layer of the epithelium was strongly pigmented (Fig. 2).