POSTOPERATIVE MORPHOLOGY AND FUNCTION OF AN AUTOGRAFT OF THE ABDOMINAL AORTA

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The role of the innervation system of a blood vessel in maintaining its delicately balanced capacity, and in establishing the blood flow and pressure at a rate and height necessary for metabolic reactions not only in the organ supplied by that given blood vessel, but in the vessel wall itself, is well known [1].

It has been shown [2-4] that the complex innervation system of the aorta not only ensures an adequate response of its wall to changes in tissue homeostasis, but also controls the nutrition of the aortic wall itself.

The effect of the innervation system on permeability of the endothelial layer of main blood vessels has not yet been adequately studied. Information is lacking on functional changes in the denervated and devascularized vessel wall. An autograft can be regarded as a classical model of a denervated and devascularized blood vessel.

The aim of this investigation was to study changes in an autograft of the abdominal aorta in the immediate period after the operation.

EXPERIMENTAL METHOD

Autografting of the abdominal aorta was performed on 40 mongrel dogs. At intervals of 1, 12, and 24 h and also on the 5th and 10th days after the operation the animals were anesthetized by intravenous injection of 5% thiopental sodium. The aorta was isolated along its whole length. Equal segments were excised from the arch of the aorta (A-1), the thoracic aorta (A-2), the zone of autografting (A-4), and also areas immediately above (A-3), and below (A-5) the site of the graft. Saline extracts were prepared from equal weighed samples of the excised regions of the aorta in Tris-glycine buffer (pH 8.8), in which total protein was determined by Lowry's method and protein fractions by disc electrophoresis by Maurer's method in 7% polyacrylamide gel (pH 8.9). At these same times after autografting of the abdominal aorta, under thiopental sodium anesthesia a 0.3% solution of acridine orange in 0.9% sodium chloride solution was injected intravenously in a dose of 1.5 ml/kg body weight. The abdominal aorta was excised along its whole length 20 sec after the injection of acridine orange. A series of histological sections was cut on a cryostat from the aorta in the zone of the graft and above and below it. The sections were examined under the luminescence microscope. The intensity of luminescence and depth of spread of acridine orange into the various layers of the aortic wall were determined. The zone of the graft and adjacent regions of the aorta of animals studied 24 h and 5 and 10 days after the operation were examined with the scanning electron microscope. Pieces of aorta were fixed in 1% glutaraldehyde in phosphate buffer, pH 7.4, and dehydrated by the usual method. The preparations were sprayed with Permoloy to give a thickness of the sprayed layer of 50 Å. The surface of the endothelial lining of the aorta and its collagen-elastic framework were studied. Numerical results were subjected to statistical analysis.

EXPERIMENTAL RESULTS

One hour after the operation the total protein concentration was 2.7 ± 0.9 mg/ml in the wall of the aortic arch, 0.87 ± 0.43 mg/ml in the thoracic aorta, 1.6 ± 0.7 mg/ml above the graft, 2.84 ± 0.9 mg/ml in the graft, and 2.1 ± 0.62 mg/ml in the zone below the graft (Fig. 1). Protein fractions also were distributed irregularly. Their concentrations were higher

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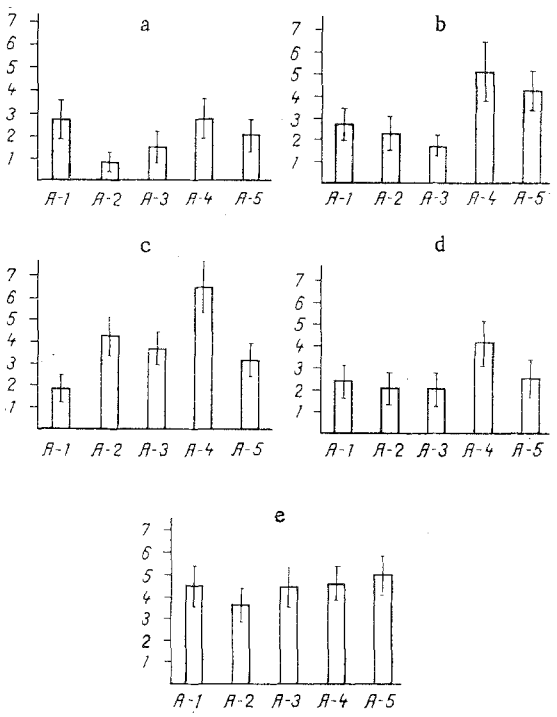

Fig. 1. Total protein concentration (in mg/ml) in areas A-1, A-2, A-3, A-4, and A-5 1h (a), 12 h (b), 24 h (c), 5 days (d), and 10 days (e) after operation.

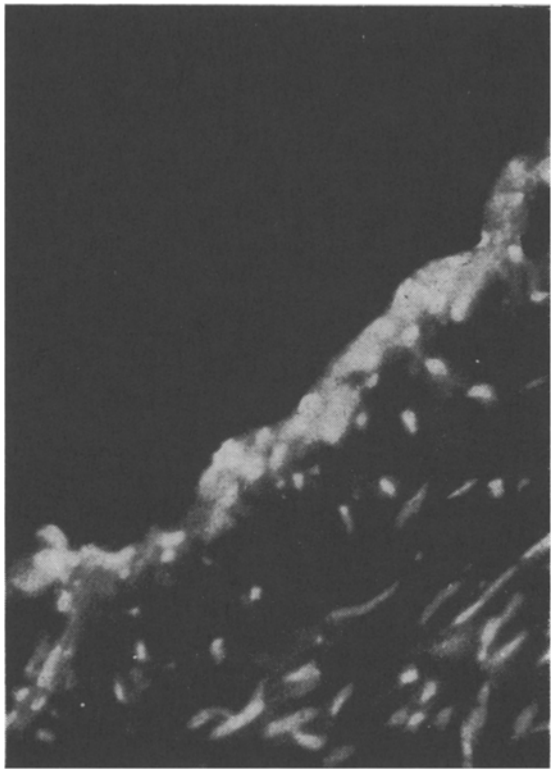

Fig. 2. Distribution of acridine orange in autograft 24 h after operation. Luminescence microscopy. 100 ×.

Fig. 3. Scanning electron micrograph of autograft on 10th day after operation: marked deformation and swelling of collagen fibers (4000×).

in the zone of the graft [7] than above or below it. Intense fluorescence of acridine orange in cell nuclei of the endothelium and subendothelial layer of the autograft was discovered 1 h after the operation.

After 12 h the total protein concentration was 2.8 ± 0.72 mg/ml in the wall of the aortic arch, 2.3 ± 0.68 mg/ml in the thoracic aorta, 1.08 ± 0.4 mg/ml in the zone above the graft, 5.1 ± 1.3 mg/ml in the graft, and 4.4 ± 0.9 mg/ml in the zone below the graft. The concentrations of the protein fractions remained unchanged in the zone of the graft. Increased penetration of acridine orange in the autograft and also in segments of the aorta above and below the graft was found.

Scanning electron micrographs 24 h after the operation revealed desquamation of the endothelium, with distinct separation of the endotheliocytes in some areas and with the formation of interendothelial "ports."

At this stage the total protein concentration in the aortic arch was 1.9 ± 0.5 mg/ml, in the thoracic portion 4.3 ± 0.8 mg/ml, in the zone above the graft 3.7 ± 0.6 mg/ml, in the graft 6.8 ± 1.2 mg/ml, and below the graft 3.26 ± 0.7 mg/ml. There was a marked tendency for the qualitative composition of the protein fractions to change in the zone of the graft.

Irregular penetration of acridine orange in the wall of the autograft was observed 20 sec after injection of acridine orange and the zone of fluorescence of the cell nuclei and fibrous structures occupied half of the cross section of the aortic wall (Fig. 2).

On the 5th day after the operation scanning electron microscopy revealed swelling, signs of deformation, and untwisting of the collagen fibers of the aortic wall in the region of the graft. The total protein concentration was as follows: 2.7 ± 0.6 mg/ml in the wall of the aortic arch, 2.3 ± 0.57 mg/ml in the thoracic aorta, 2.5 ± 0.61 mg/ml above the graft, 4.4 ± 0.92 mg/ml in the zone of the graft, and 2.8 ± 0.7 mg/ml below the graft. After injection of acridine orange, dead cells were observed in all layers of the aorta in the zone of the graft, with fluorescence of fibrous structures. On the 10th day most of the autograft was denuded of endothelium. Scanning electron microscopy revealed course deposits of fibrin,

covering the areas of the autograft denuded of endothelium. The collagen fibers were greatly deformed and junctions between collagen and elastic fibers were disturbed (Fig. 3).

The total protein concentration was 4.3 ± 0.8 mg/ml in the aortic arch, 3.7 ± 0.62 mg/ml in the thoracic aorta, 4.3 ± 0.82 mg/ml above the graft, 4.5 ± 0.9 mg/ml in the graft, and 4.9 ± 0.9 mg/ml below the graft. There was a sharp increase in the number of macromolecular protein fractions in the zone of the autograft.

It can be concluded from analysis of the results that denervation and devascularization cause contraction of endotheliocytes and the formation of interendothelial "ports" during the hours immediately after the operation. This process facilitates rapid imbibition of blood by the vessel wall. Absence of transport of blood in the vessel wall leads to death of cells in all layers of the aorta and to desquamation of the endothelium. The fibrous structures of the aorta are most resistant to hypoxia and denervation. On the 10th day after denervation and devascularization irreversible changes take place in the collagen-elastic framework of the aorta, and these must adversely affect the strength and durability of vascular autografts.

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COMMISSURAL MECHANISMS OF RESTORATION OF VISUAL FUNCTION

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Recent investigations have demonstrated the great importance of forebrain commissures in the conduction of sensory impulses to the cerebral cortex [1, 2, 5, 6, 8]. Recent research by the present writers [4, 5] has shown that commissural projections of the visual and somatosensory systems are functionally highly effective. The callosal projections of these systems show features of topical organization [3, 4], evidence of the complexity of interhemispheric integration of sensory signals. It will be evident that the commissural systems of the forebrain, with their complex organization, their considerable size, and their functional effectiveness, are an important factor in the compensation of sensory functions in lesions of the principal afferent pathways.

The object of the present investigation was accordingly to study the dynamics of compensatory-repair processes in the CNS of cats after unilateral division of the optic tract, and with the commissures of the telencephalon, diencephalon, and mesencephalon either intact or completely divided.

EXPERIMENTAL METHOD

Experiments were carried out on 15 adult cats divided into three groups: 1) control animals, 2) cats with division of the left optic tract, 3) animals with division of the left optic tract and of commissures of the telencephalon, diencephalon, and mesencephalon. The fields of vision were measured monthly in all animals (in the cats of groups 2 and 3, 1 month

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