CHANGES IN THE INTIMA OF VEINS FOLLOWING CHEMICAL ACTION ON THEIR WALLS

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(Received November 26, 1957. Presented by Active Member of the AMN SSSR N. G. Khlopin)

During the last ten years new information has been obtained on the tissue properties of the endothelium of the vascular system in the vertebrate animals and man [1-13]. However, there still remain many unsolved and doubtful problems in this field.

The present investigation was devoted to the study of changes in the endothelial lining of the jugular veins of rabbits after the action of crystals and concentrated solutions of sodium chloride on their walls.

EXPERIMENTAL METHOD

In some experiments the wall of the jugular vein was exposed under aseptic conditions, and then a small crystal of sodium chloride was applied to the outside of the exposed area for 5-6 minutes. In other experiments

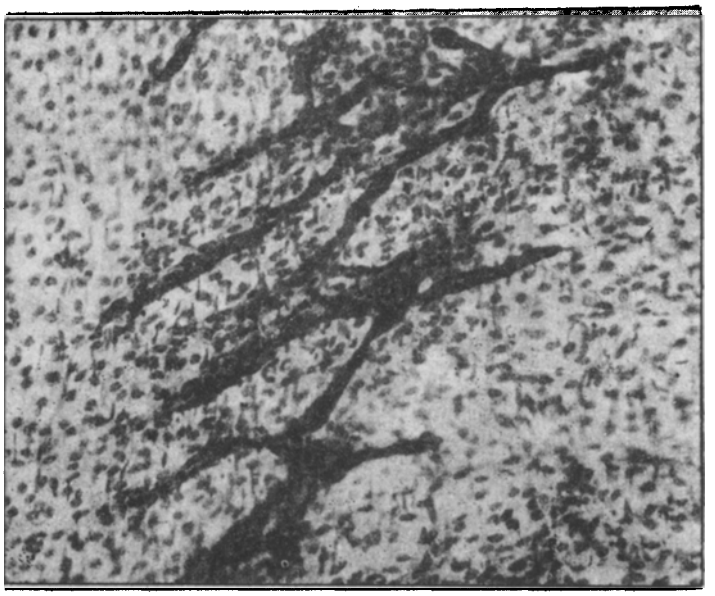

Fig. 1. Internal surface of the jugular vein of a rabbit 4 days after trauma. Multiple proliferations of the intima in the region of application of a crystal of sodium chloride. Total plane preparation. Iasvoin's hematoxylin stain. Microphotograph. Magnification: objective 20 ×, ocular 7 ×.

a solution of 20% sodium chloride was injected from a syringe into the external coat of the vein, in a dose of about 0.1 ml, and in a short time this infiltrated through the outer coat and partly through the muscular coat. In each case the operation wounds were closed in layers. The animals were killed on the 2nd-10th day, the damaged vessels were resected and incised longitudinally along the side opposite the point of action of the salt. After fixation in alcohol, total preparationswere made from the vessels, and stained with hematoxylin by Iasvoin's method, with preliminary impregnation of the cell margins of the endothelium with a 0.25% solution of silver nitrate or without this addition. Altogether 18 preparations of jugular veins were examined.

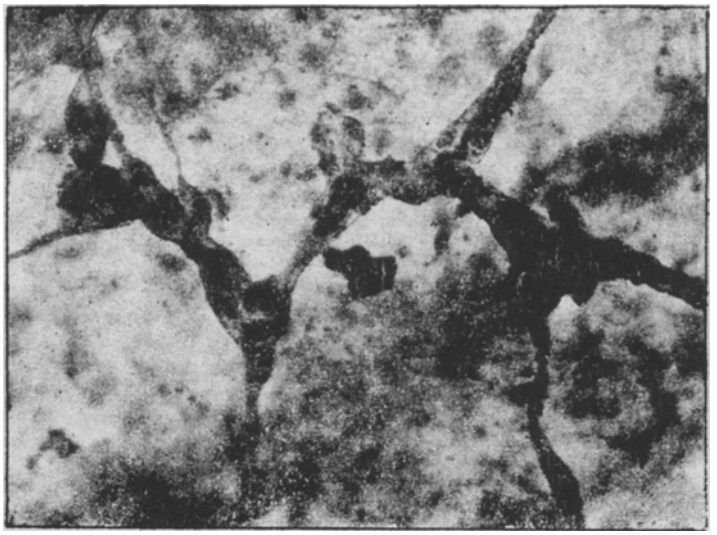

Fig. 2. Endothelial proliferation in the lumen of the jugular vein of a rabbit 6 days after injection of sodium chloride solution into the wall. Total plane preparation. Iasvoin's hematoxylin stain. Microphotograph. magnification: objective 40 ×, ocular 10 ×.

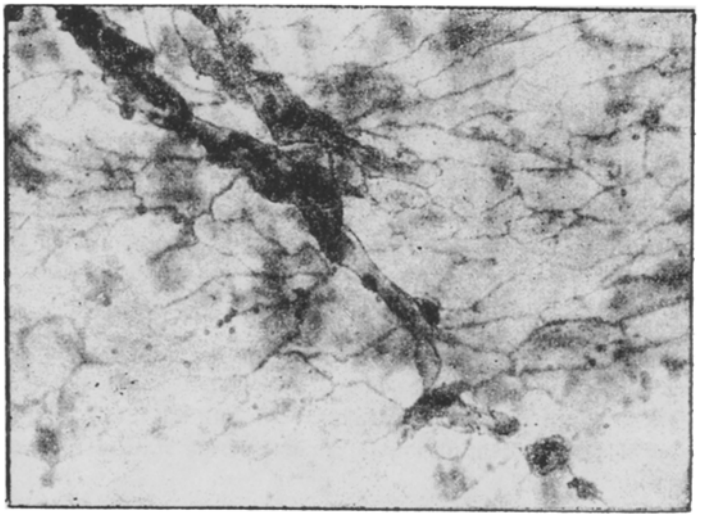

Fig. 3. Internal surface of the jugular vein of the rabbit 10 days after injection of sodium chloride solution into its wall. Transformation of an endothelial projection in the vein into an endothelial intravascular proliferation. Plane preparation. Margins of the endothelium impregnated with silver, Iasvoin's hematoxylin stain. Microphotograph. Magnification: objective 40 ×, ocular 10 ×.

EXPERIMENTAL RESULTS

During examination of the preparations in which it was possible to trace not only the initial coat throughout its full extent but also all the other coats of the vein walls, considerable proliferation of the intima into the lumen of the vessel was observed in nearly all the damaged veins. These began to appear on the 2nd-3rd day after the experimental chemical action and were very clearly marked after 4-10 days. The character of the proliferations was similar whatever the mode of trauma, and so they will be described together; in relation to the intensity of the lesion of the intima and of its area there are appreciable differences. After the action of a crystal of sodium chloride on the outer coat of the vein a considerable larger part of the intimal coat was affected than after injection of the salt solution into its wall. In the first case the dimensions of the proliferation were greater and their number larger than in the second case. This may be due to the fact that at the site of application of the crystal a very concentrated saline solution is formed.

The proliferations of the intima are in the form of single or multiple bands and threads which are joined at one, or – as is observed much more often – two ends to the intima (Figs. 1, 2, and 3). They are to a large extent freely disposed in the lumen of the vessel and are bathed in blood. Often the bands are interconnected and form a complex binding (see Fig. 1). In other cases in a group of proliferations there is one band which is thicker than the others, usually centrally situated, and joined by several thinner septa to the intima.

The majority of the proliferations consist of endothelium only, and their thickness is very insignificant (see Figs. 2 and 3); others, which are thicker, are composed of fibrous connective tissue covered with endothelium. The purely endothelial proliferations (see Figs. 2 and 3), which are derived from the initial endothelium of the vein, are of the greatest interest. In preparations in which the margins of the endothelial cells are impregnated with silver, the transformation of the endothelium of the wall of the vein into the endothelium of the bands extending into the lumen of the vessel (see Fig. 3) is clearly seen. In proliferations with a fibrous connective tissue basis, its connection with the connective tissue of the intima can readily be traced. On the 2nd-4th day after the chemical action of the vessel numerous mitoses can be seen in the cells of the endothelial lining. These facts provide one more confirmation of the ability of the endothelium, even of major vessels such as the jugular veins of the rabbit, to proliferate actively in response to trauma and to give rise to intravascular proliferations.

It was possible to trace the method of formation of these proliferations. In some places the surface of the intima becomes uneven on the 2nd-5th day and the endothelium forms either single or multiple projections which then increase in length although not beyond the bounds of microscopic dimensions. These projections are pin-head or dome-shaped. In some of the traumatized veins they attain a considerable length and hang in the lumen of the vessel in the direction of the blood flow. The very long and thick bands seen in the carotid and femoral arteries [6, 8] and in the aorta [1, 2] could not be observed. The possibility is not excluded that they may become very long in the veins too, then become attached by their free end to the intima of the vessel, forming bands fixed by both ends to the vessel wall.

In other cases thickenings are found in the intima of the vein in the form of rods directed with the blood flow. Subsequently the middle portion of a rod, consisting of connective tissue covered with endothelium becomes separated from the vessel wall and forms a bridge, freely disposed in the lumen of the vessel and connected to its wall by its ends. This method of formation of intravascular proliferations of the intima is clearly traceable in histological preparations.

On the internal surface of some vessels appear, in addition to the proliferations mentioned above, funnel--like craters, lined with endothelium. They are not deep and terminate blindly. It may be considered that these formations arise in consequence of infiltration of the endothelium into the thickness of the vessel wall. They are probably the initial stages of development of new intramural vessels similar to those described elsewhere [1-3, 6-8, 13].

The results obtained show that stimulation of the wall of a vein with chemical substances with a relatively low traumatic power causes proliferation of the intima which alters the hemodynamics in this section of the vessel. They lead to interference with the blood flow and to stasis, as a result of which favorable conditions are created for partial or complete thrombosis of the vessel. These findings confirm once again the necessity of using harmless operative agents during various procedures on the vessels in order to avoid undesirable late consequences.

From a comparison of the findings described in this paper with those in the literature it is impossible to escape from the conclusion that during trauma to the wall of a blood vessel there is regularly found a biological

reaction of the endothelium, as shown by the active mitotic growth of this tissue and the formation of intravascular and intramural endothelial proliferations.

SUMMARY

An active mitotic proliferation of endothelium was found in rabbits following the action of sodium chloride crystals or 20% solution of sodium chloride on the outer coat of the jugular veins. Later, the endothelial outgrowths were revealed both in the veins and within their walls.

LITERATURE CITED

[1] F. V. Baliuzek, Resection of the Aorta (Experimental Investigation),* Candidate's Dissertation Leningrad, 1955.

[2] Idem, Doklady Akad. Nauk SSSR 109, No. 5, 1039-1040 (1956).

[3] L. B. Berlin, Ibid. No. 4, 859-861 (1956).

[4] N. L. Kamenskaia, Changes in the Endothelium of the Human Aorta in Ontogenesis (Histological Investigation),* Candidate's Dissertation, Leningrad, 1956.

[5] N. A. Kolesnikova, Experimental Histological Investigation of the Endothelium of the Lymphatic Sacs,* Candidate's Dissertation, Leningrad, 1946.

[6] A. D. Smirnov, Doklady Akad. Nauk SSSR 93, No. 4, 705-708 (1953).

[7] Idem, Changes in the Endothelium During Clamping of a Vessel Wall (Experimental Histological Investigation),* Candidate's Disseration, Leningrad, 1954.

[8] Idem, Vestnik Khirurg im. Grekova No. 8, 74-82 (1955).

[9] N. G. Khlopin, Doklady Akad. Nauk SSSR 109, No. 4, 865-868 (1956).

[10] N. G. Khlopin and N. M. Chistova, Ibid. 114, No. 2, 425-429 (1957).**

[11] N. A. Shevchenko, Ibid. 70, No. 4, 703-705 (1950).

[12] N. A. Shevchenko, Ibid. No. 5, 879-882 (1950).

[13] N. A. Shevchenko, Ibid. No. 3, 83, 473-476 (1952).

* In Russian.

** See English translation.