MORPHOLOGICAL CHANGES IN THE VITREOUS BODY IN HEMOPHTHALMIA ACCOMPANIED BY INTRAVITREAL HEMATOMA

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KEY WORDS: mechanical action of intravitreal hematoma, collapse of the vitreous body, detachment of the vitreous body, hemosiderin granules.

There is an abundance of data on changes of a destructive character, existing for a long time in the vitreous body (VB) in hemophthalmia, with visible swelling, condensation, and adhesion of the vitreal membranes [11, 13, 14], and also with their disintegration and liquifaction of VB in connection with depolymerization of hyaluronic acid [2, 9, 10]. As a rule these changes are connected with the action of blood cells and their breakdown products, namely hemoglobin, iron, and protein, which are either adsorbed by cells of VB or form chemical compounds with them [5, 8, 9].

As yet, however, no attempt has been made to study the effect of intravitreal hematoma on VB, because the view is predominantly held that VB is saturated with blood regardless of the type of bleeding [2, 8, 12]. Meanwhile, one of us (E.G.R.) demonstrated previously the formation of an intravitreal hematoma in hemophthalmia connected with rupture of the blood vessels of the eye [3, 4].

Accordingly, in the present investigation an attempt was made to study the character of morphologic changes in VB connected with the effects of an intravitreal hematoma.

EXPERIMENTAL METHOD

Experiments were carried out on 74 rabbits weighing 1.5-2.5 kg. Under local subconjunctival or retrobulbar procaine anesthesia, a model of hemophthalmia was produced by injecting various volumes (from 0.1 to 1.2 ml) of autologous blood taken from the auricular vein, into VB by means of a needle and syringe. The sclera was punctured in the flat part of the ciliary body after preliminary paracentesis. The animals were decapitated at various times (from 1 h to 3.5 years) after a single or repeated (2-4 times) injection of blood, the eyes were quickly enucleated, 0.1 ml of VB was aspirated (by puncture of the sclera), and a native drop of VB was examined under the microscope and films investigated cytologically by the usual method. The eyeballs were then fixed in 10% formalin solution, which was injected into VB. The eyeball was then cut into three sagittal blocks, subjected to the usual histologic treatment, and then embedded in celloidin and paraffin wax. Sections were stained with hematoxylin and eosin, by Weigert's, Mallory's, and Shueninov's histochemical reactions for fibrin, Van Gieson's and Mallory's methods for connective tissue, and Peris' method for iron.

Material for electron microscopy was fixed in a mixture of paraform and glutaraldehyde then postfixed in 1% OsO_4 solution. Ultrathin sections were studed in the UMV-100K and Tesla BS-500 electron microscopes.

EXPERIMENTAL RESULTS

After injection of the blood and until the 6th-7th month, when the volume of blood injected was large, a hematoma was visible in the cavity of VB on section of the eyeball (Fig.

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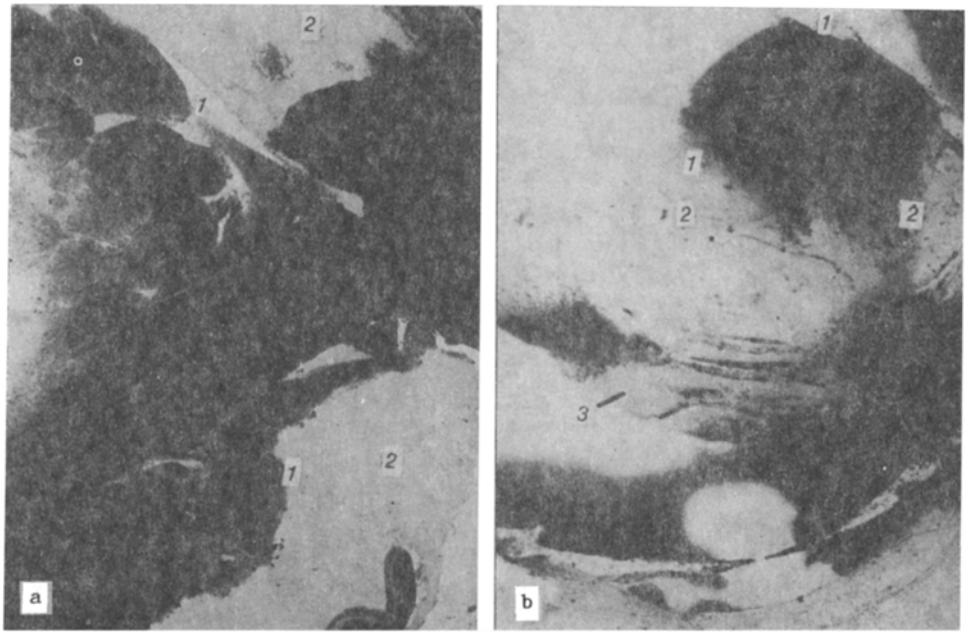

Fig. 1. State of VB at different times of hemophthalmia: a) 3 h after injection of blood VB (2) remained transparent in the immediate vicinity of the hematoma (1); b) delicate films of VB (2) on 3rd day of hemophthalmia, in the presence of a hematoma (1) located posteriorly to the lens (3). Stained with hematoxylin and eosin. Magnification 35.

1). On the 1st day VB remained transparent (Fig. 1a). After the 2nd day examination of the eyeball revealed pink coloration of VB around the hematoma. After the 3rd-5th day the whole of VB became red, with the presence of floccules containing threads of blood (Fig. 1b). On the 2nd-3rd day VB lost its viscosity, became liquid, and contained a red suspension. On the 5th-6th day, on section of the eyeball syneresis of VB could be seen on the surface of the hematoma, with detachment of VB together with the retina (Fig. 2a), and the formation of red membranous structures, adjacent to the lens, the hematoma, and the vitreal tract, with synchysis of the surrounding mass of VB. One month after injection of small volumes of blood the viscosity of VB was restored and the films in VB disappeared. If large volumes of blood were injected, or small volumes injected repeatedly, 3-7 days after modeling of the process, and also at later stages, the detached VB, together with the retina, was found to be adherent to the hematoma. In some cases, most frequently after repeated injections of small volumes of blood (three or four injections) VB became a dense homogeneous mass of gelatinous consistency. After a few years, in cases of extensive hemorrhages and "recurrent" hematomas, subatrophy and atrophy of the eyeball were frequently found as the outcome of the process, with complete overgrowth of the cavity of VB.

Besides a hematoma, histologic examination of VB on the 1st day after injection of blood frequently revealed an accumulation of amorphous and fibrin threads, with or without solitary erythrocytes. The possibility cannot be ruled out that this morphological substrate of films, detectable clinically after the first few hours of hemophthalmia, is the result of plasmarrhagia, due to increased permeability of the vessels at the time of trauma. On the 3rd-7th day of hemophthalmia a condensed network of VB fibrils could be seen around the hematoma (Fig. 2b), with groups of whole erythrocytes and their derivatives deposited on them, and with detachment of VB. On the 3rd-7th day, as a rule, light microscopy revealed multiple film-like structures, which differed sharply in structure from the hematoma (Fig. 3). These films contain amorphous threads and a delicate fibrin network, with scattered erythrocytes and macrophages or with discrete groups of them. These films contained no large clumps of fibrin characteristic of the structure of the hematoma. Erythrocytes were distributed diffusely in them, as also were phagocytes, which could be seen uniformly throughout the film (Fig. 3). In all parts of the film hemolysis of erythrocytes was delayed compared with that in the central zone of the hematoma and had not appeared on the 3rd-7th day, and most frequently it took place intracellularly. Gradually the number of erythrocytes deposited on the preretinal and perilenticular fibers of VB increased to reach a maximum on the 12th-35th

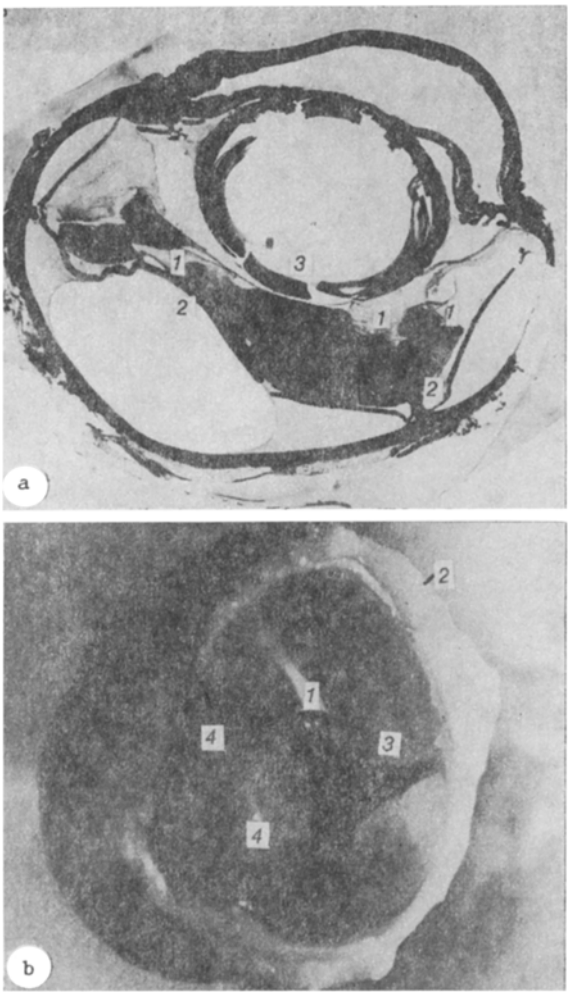

Fig. 2. Changes in structure of the eyeball on 6th day of hemophthalmia: a) condensation of fibers of VB with its detachment together with the retina (2) on surface of hematoma (1) with perilenticular localization (3). Hematoxylin and eosin, 40 ×; b) early mechanical detachment of VB and retina (3) with condensation of VB fibers on surface of hematoma (1), located posteriorly to the lens (4). Section through enucleated eye (2). Natural specimen, 2 ×.

day (in 75-80% of cases). After 5-6 months, as a rule, no single erythrocytes were found in VB. Study of the native VB or cytologic investigation revealed erythrocytes in the liquid part of VB already on the 3rd-5th day.

Electron-microscopic investigation after 1 month also revealed single whole erythrocytes at a distance from the hematoma in the modified VB (Fig. 4b). On the 7th day destructive changes were found in the VB fibrils (Fig. 4b). Fibers of VB, lysed and reduced in thickness, with disturbances of its network in the form of separate parallel bands, instead of the interwoven network of the normal VB, can be seen in Fig. 4b. At these same periods of hemophthalmia, numerous amorphous electron-dense granules, similar in optical density and configuration to hemosiderin granules, could be seen among the interwoven fibers (Fig. 5). After 1 month these granules were seen irregularly, and they can be taken as a morphologic manifestation of early hemosiderosis of VB.

The results showed that as early as by the 3rd-7th day the fibers and tracts of VB had collapsed and condensed on the surface of the hematoma, to be followed by detachment of VB. In our view this may be connected with the mechanical action of the hematoma on VB, in agree-

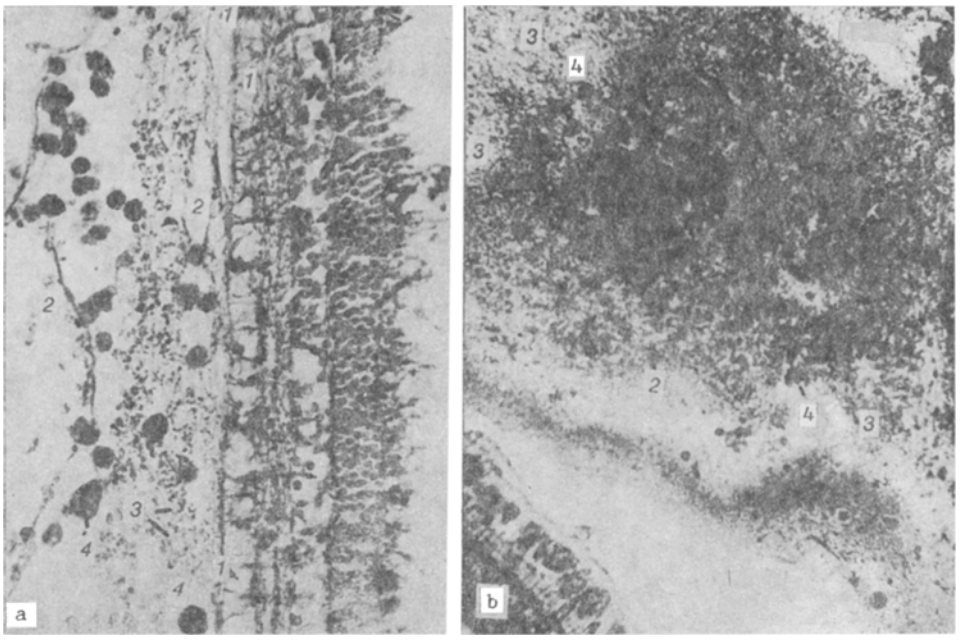

Fig. 3. Structural changes in VB on 6th day of hemophthalmia: a) periretinal localization of film of VB: retina (1), altered fibrils of VB (2), erythrocytes (3), macrophages (4). Hematoxylin and eosin, 200 ×; b) diffuse distribution of erythrocytes (3), macrophages (4) in network of fibrin threads and fibers of VB (2), in films of VB close to hematoma (1). Perls' reaction 100 ×.

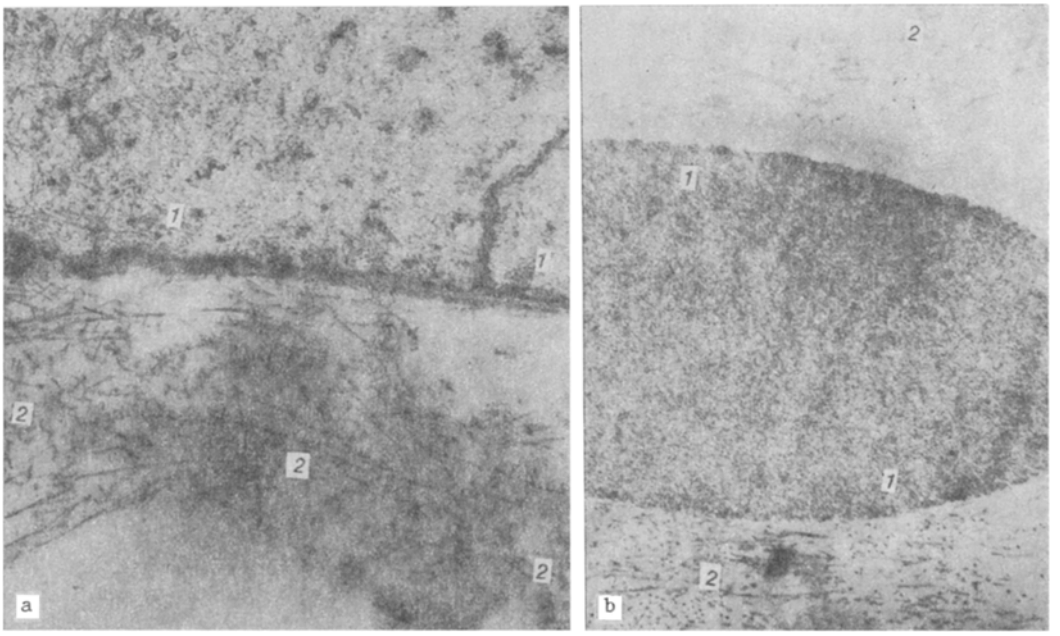

Fig. 4. Changes in fibrillary network of VB in course of hemophthalmia: a) normal structure of preretinally arranged fibrils of VB (2) on 1st day after injection of blood: retina (1); b) hemorrhagic infiltration of VB 1 month after hemophthalmia: solitary erythrocytes (1) among lysed fibrils of VB (2). Here and in Fig. 5: 26,400 ×.

ment with the opinions of several Soviet ophthalmologists on the essential role of biomechanical factors in the pathology of VB [3, 4].

An intravitreal hematoma thus induces mechanical changes in VB, which are manifested as concentration, condensation, and collapse of the fibers of VB on its surface on the 3rd-

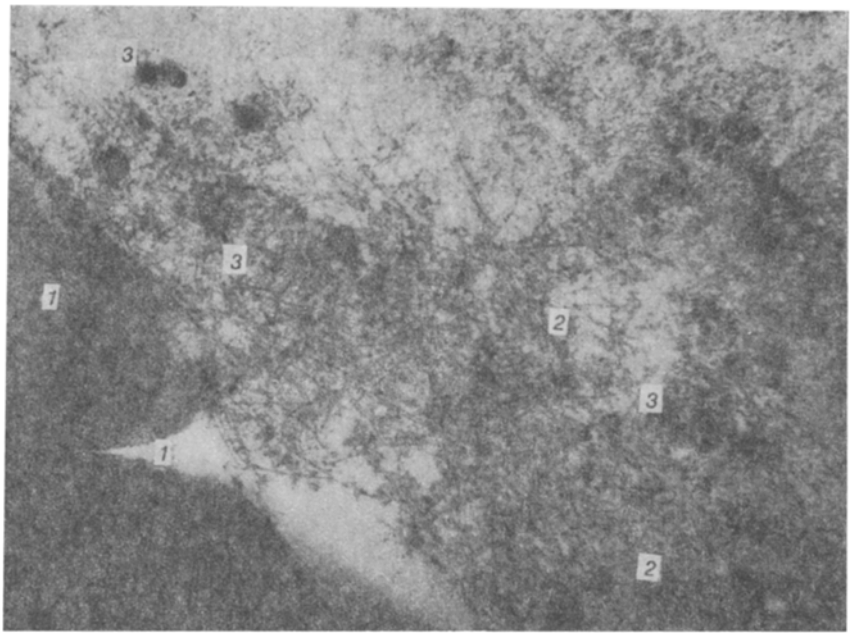

Fig. 5. Dense network of fibrils of VB (2) near hematoma (1), containing optically dense granules (3).

5th day of hemophthalmia, followed by syneresis and detachment of VB. The well-marked mechanical effects of an intravitreal hematoma on VB can evidently be explained by the unique structure of the vitreous body, which is in a semiliquid phase and possesses a skeleton of thin collagen fibers. Furthermore, during disintegration the hematoma induces a combination of physicochemical changes in the composition of VB [8, 9], which are by no means all revealed morphologically. However, the results are evidence of a long disturbance of protein and elementary metabolism (in particular, of proteinophthalmia and early hemosiderosis of VB), which itself may be the basis for opacity of VB. Meanwhile changes in pH of the medium can trigger a series of chemical reactions, leading to various structural disturbances.

The investigations showed that mechanical, physicochemical, and biological effects of a hematoma induced morphological changes of a quite uniform type in VB, manifested as syneresis and condensation of some zones and synchysis of other zones of VB and by the formation of films in the regions of condensation and also of structures uncharacteristic of VB.

These results can be used in clinical practice to draw up indications for radical intervention in forms of hemophthalmia when irreverisble changes in VB are inevitable.

LITERATURE CITED

1. V. A. Agafonov and Ya. I. Glinchuk, Vest. Oftal'mol., No. 2, 57 (1984).
2. V. P. Makarova, M. N. Sorokina, I. P. Khoroshikova-Maslova, et al., Oftal'mol. Zh., No. 7, 427 (1984).
3. E. G. Rapis, Zdravookhr. Turkmenistana, No. 1, 7 (1979).
4. E. G. Rapis, M. D. Shmerling, E. E. Filyushina, et al., Byull. Éksp. Biol. Med. No., 9, 114 (1982).
5. V. A. Rykov, Vest. Oftal'mol., No. 2, 64 (1984).
6. V. A. Smirnov, Diagnosis and Treatment of Eye Diseases [in Russian], Kazan' (1967), pp. 218-220.
7. A. N. Shumailova, Oftal'mol. Zh., 29, 297 (1974).
8. J. M. Burke, E. Sipos, and H. E. Cross, Invest. Ophthalm., 20, 575 (1981).
9. J. Carr, The Macrophage. A Review of Ultrastructure and Function, London (1973).
10. P. A. Cibis and T. Yamasita, Am. J. Ophthalmol., 48, 465 (1959).
11. G. Cornand, Canad. J. Ophthalmol., 117, 66 (1973).
12. R. H. Fenton, F. B. Johnson, and L. E. Zimmerman, J. Histochem. Cytochem., 12, 153 (1984).

13. K. O'Steen and Z. A. Kereiglic, Am. J. Anat., 139, 503 (1974).
14. I. H. La Nauza, R. M. Hembry, W. Jácobson, and P. G. Watson, Exp. Eye Res., 34, 803 (1982).

ULTRASTRUCTURAL CHANGES IN CARDIOMYOCYTES AND CAPILLARIES OF HEART MUSCLE AFTER VAGOTOMY AND PHYSICAL EXERCISE

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The trophic role of the vagus nerve and its role in the pathogenesis of myocardial dystrophies are among the most important problems in medicine. Numerous investigations [1, 3, 9, 11, 13] have shown that blocking extracardial parasympathetic nervous influences on the heart is accompanied by a disturbance of the tissue catecholamine balance, by changes in some metabolic processes, and by profound morphologic disturbances. The attention of research workers has been drawn particularly to adaptation of the heart during physical exercise and the trophic role of the vagus nerve and its role in the maintenance of myocardial function [2, 4, 5, 10, 12].

In the investigation described below an ultrastructural study of the cardiomyocytes and capillaries of heart muscle was undertaken after extracardial parasympathectomy and measured physical exercise.

EXPERIMENTAL METHOD

Experiments were carried out on 30 adult male noninbred albino rats weighing 200-225 g. The animals were divided into three groups: 1) control, 2) rats made to carry out measured physical exercise (submaximal and maximal), 3) animals subjected to partial surgical left-sided parasympathetic denervation and subsequently doing measured physical exercise. The tests were carried out on the 5th, 7th, and 14th days. Left-sided vagotomy in the lower third of the neck was performed under sterile conditions and ether anesthesia. Animals of groups 2 and 3 did physical exericse twice on an electric treadmill for 30 min with an interval of 24 h. A speed of 20.9 m/min was chosen for submaximal exercise, 29.8 m/min for maximal. Immediately after measured physical exercise the animals were decapitated and the heart removed. Pieces of tissue from the left ventricle were minced in 1% OsO_4 solution in phosphate buffer, pH 7.4, and fixed for 2 h, and then dehydrated and embedded in Epon and Araldite. Sections 20-50 nm thick were cut on the Tesla BS-490A ultramicrotome and examined in the UÉMV-100V electron microscope.

EXPERIMENTAL RESULTS

An electron-microscopic study of the left ventricle of the animals of group 2 after submaximal physical exercise revealed trivial ultrastructural changes in the cardiomyocytes. Most of the myocardial muscle cells were virtually indistinguishable from the control. In some places, however, the cell nuclei were enlarged, the nuclear membrane showed numerous recess-like indentations, and the chromatin in the nucleoplasm was condensed into clumps. The nucleolus was displaced toward the periphery. In some cardiomyocytes the mitochondria were enlarged and their matrix translucent. Cisterns and tubules of the sarcoplasmic reticulum were dilated. The lamellar apparatus consisted of tiny vesicles and the regular orientation of the myofibrils was disturbed. The capillary endotheliocytes contained

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