39 (78%) there was no correlation between these values. Statistical analysis thus showed that the content of newly synthesized RNA in the nucleolus is not uniform. This nonuniformity is most probably not attributable to an error of the method but must exist objectively. Differences in the content of newly synthesized RNA in different zones of the nucleolus can be due to the following causes: 1) a nonhomogeneous distribution of rRNA genes in the mass of the nucleolus; 2) the existence of definite sites in the nucleolus for accumulation of newly synthesized RNA; 3) an alternating pattern of work of the rRNA genes.

Further investigations are necessary to determine the real worth of these hypotheses.

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DETACHMENT OF THE RETINA IN EXPERIMENTAL HEMOPHTHALMIA

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KEY WORDS: intravitreal hematoma; collapse of the vitreous body; early detachment of the retina.

Irreversibility of pathological changes in the retina in hemophthalmia is often attributable to its total detachment [4, 9, 12]. It has recently been shown by ultrasonic B scanning that clinically observed detachment of the retina may show particular structural features incompatible with the recovery of visual functions [9]. However, the causes of these detachments have not been sufficiently studied. Information in the literature do not indicate conclusively whether it is blood or the trauma accompanying hemophthalmia that leads to the development of detachment of the retina [2, 8, 11]. Until recently, when the causes of detachment of the retina in hemophthalmia were analyzed, the role of intravitreal hematoma was ignored, although my own previous investigations showed that it is invariably present should hemorrhage into the vitreous body (VB) arise because of rupture of a blood vessel [5].

It was accordingly decided to make a special study of the state of the retina in experimental intravitreal hematoma.

EXPERIMENTAL METHOD

Experiments were carried out on 52 albino and chinchilla rabbits of both sexes weighing 1.5-2.5 kg (97 eyes). Under local anesthesia (1% procaine solution, subconjunctival or retrobulbar injection) a model of experimental hemophthalmia was produced by injecting different quantities of autologous blood (from 0.1 to 1.2 ml) taken from an auricular vein, into VB by means of a syringe and needle. The sclera was punctured in the flat part of the cil-

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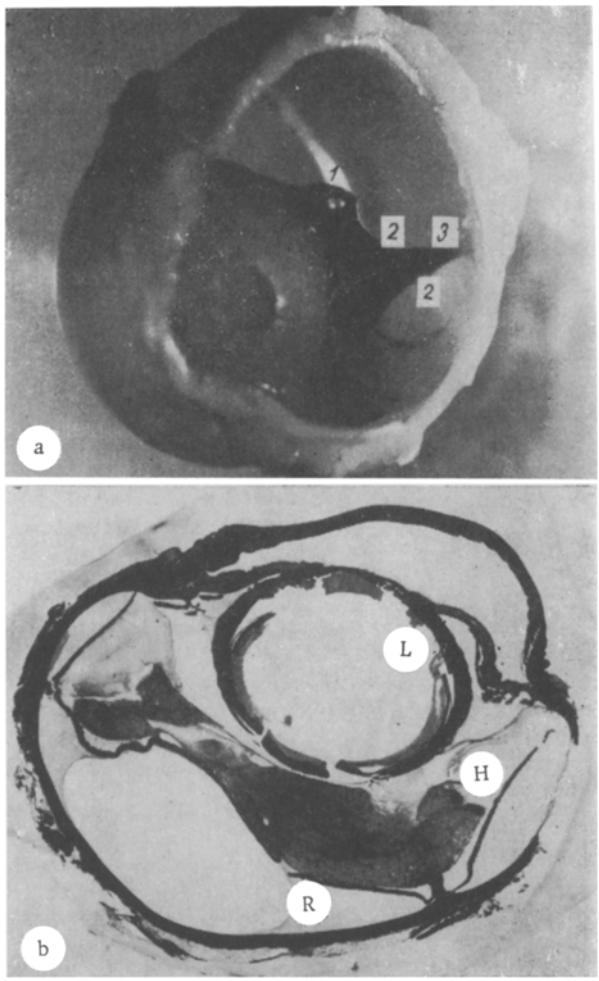

Fig. 1. Early mechanical detachment of BV and the retina on 6th day of hemophthalmia (0.3 ml blood). a) Condensation of fibers of VB on surface of hematoma (1) combined with fusiform condensation of VB (2) and mechanical detachment of retina (3). Magnification 2 ×; b) detached tissues — VB and retina (R) — appeared to cover outer surface of hematoma (H). L) Lens. Hematoxylin–eosin, 4 ×.

liary body after preliminary paracentesis. Physiological saline was injected similarly into the opposite eye of the same rabbit in the control. The animals were decapitated at different times (from 1 h to 3.5 yr) after a single or repeated (2-4 times) injection of blood, the eyes were quickly enucleated and fixed in 10% formalin, which was injected into VB. The eyeball was cut into four blocks and subjected to the usual histological treatment, followed by embedding in celloidin, paraffin wax, and gelatin. Specimens were studied macroscopically in the light microscope and histochemically (Van Gieson, PAS, Miyagawa-Aleksandrovskaya, Mallory).

EXPERIMENTAL RESULTS

Macroscopically a hematoma could be seen as early as on the 3rd day after intravital injection of blood, and if its location was preretinal, it appeared to be attached to the retina. On the 5th-6th days after injection of 0.3 ml blood (13 of 26 eyes) partial detachment of the thickened, opaque retina, connected by membranes of VB to the hematoma if the latter was perilenticular in its situation, could be seen (Fig. 1a). If the hematoma was preretinal, it was adherent to the subjacent retina in 44% of cases as early as on the 6th day.

Microscopically a partially detached retina also could be seen, and together with the contracted, collapsed VB, it covered the surface of the hematoma (Fig. 1b). At these same times

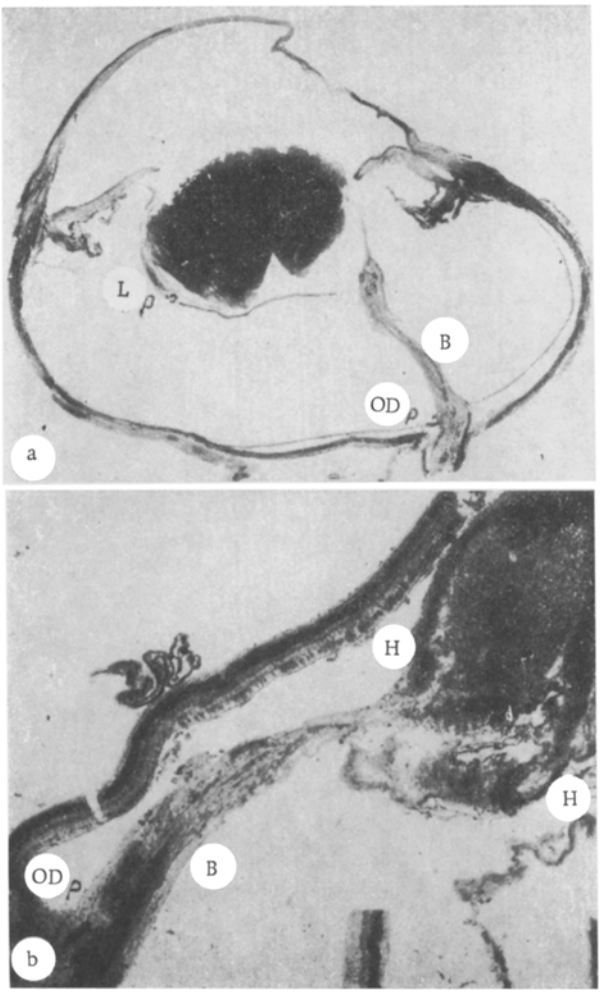

Fig. 2. Detachment of retina in late phases of hemophthalmia (2.5 yr after injection of blood). a) Connective-tissues band (B), enclosing detached retina, runs from optic disk (O. D.) to posterior capsule of lens (L). van Gieson, 4 ×; b) axial band running to hematoma (H). van Gieson, 35 ×.

proliferation of fibroblasts was observed with the appearance of collagen fibrils (positive Van Gieson's and Mallory's reactions), growing into the hematoma or into the zone of erythrocytic infiltration from the retinal vessels (nine eyes, 40%) or from the optic disk (five eyes, 23%).

On the 12th-21st days the retina most frequently was fused with the hematoma (in 61% of cases after injection of small volumes of blood and in 100% after injection of 0.8-1.0 ml blood).

On the 35th day, in the presence of small hematomas (0.3-0.6 ml blood) detachment of the retina was found rarely, although connection between the retina and hematoma was established in all these cases: Thin films and filaments ran from the retina to the hematoma. After injection of 0.8-1.0 ml blood or more, the hematoma as a rule (in 100% of cases) was fused with the detached retina. Histochemically PAS-positive fuchsinophilic fibers could be detected in the capsule of the hematoma, directly continuous with the changed retina.

No detachment of the retina could be detected 6 months after a single injection of 0.3 ml blood, and an unfavorable outcome was a rare exception. In the presence of large hematomas (0.8 ml blood or more) a well developed band with "sheets" of detached and altered retina fused to it on both sides extended from the posterior pole of the eye toward the posterior capsule of the lens in 83% of cases after 6 months, in 99% of cases after 1 year or more, and in 100% of cases after repeated injections of blood (three or four injections of 0.3 ml or two or three injections of 0.5-0.6 ml) (Figs. 2 and 3a). Often after repeated injections

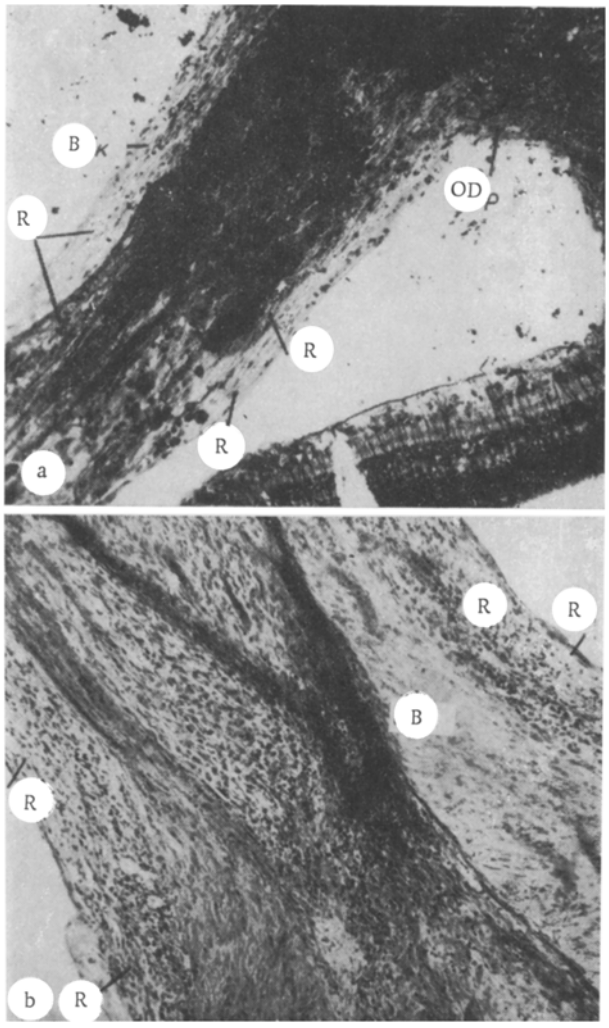

Fig. 3. Connective tissue band (B) running from optic disk (O. D.), fused into a single formation with detached and altered retina (R) on both sides peripherally. Van Gieson. Magnification: a) 100, b) 400 ×.

of blood the whole retina appeared to be immured in connective tissue which occupied the whole cavity of the eye. At these times fibrous fuchsinophilic tissue could often be observed epiretinally and with the retina, together with fibers attaching the retina to surrounding connective tissue.

Consequently, correlation was found between the volume of blood injected and the final state of the retina. With an increase in the volume of blood detachments of the retina were more frequent and became irreversible after a single injection of large volumes of blood or repeated injection of small doses. Complete death of the retina occurred in these cases with the formation of connective tissue, bone, and cholesterol crystals in the cavity of the eye (Fig. 4b, c). After repeated injections of the same fractional doses of physiological saline the outcome in the opposite, control eye of the rabbit was favorable (Fig. 4a). This shows that it was not the operative trauma, but the blood itself which causes detachment and death of the retina.

The experiments thus showed that early partial detachment of the retina occurred in hemophthalmia in 50% of cases on the 5th-7th days, in agreement with observations by other workers [7]. Later (6-8 months), in the presence of a large or recurrent intravitreal hematoma in whatever situation, total or subtotal detachment of the retina occurred in 100% of cases, with a distinctive structure which, besides connective tissue, resembled the optic nerve (Figs. 2 and 3). Other workers also have observed a morphologically similar "outgrowth" running inside the eye from the optic disk in experimental hemophthalmai [3, 7, 13], and con-

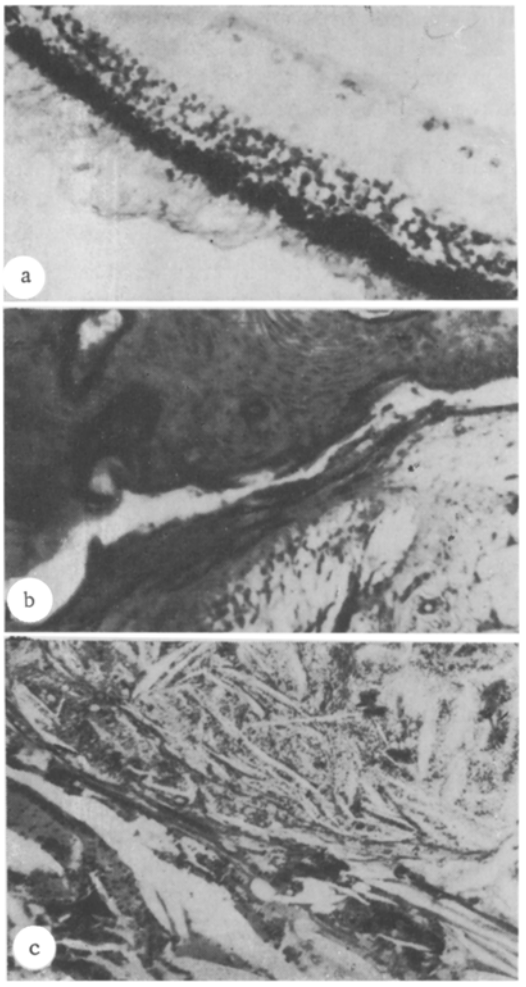

Fig. 4. Final state of retina 2.5 years after four injections, each of 0.3 ml blood or physiological saline. a) Retina unchanged after injection of physiological saline. Hematoxylin–eosin, 200 ×; b) complete necrosis of retina with formations of connective tissue in place of all membranes and with bone formation after injection of blood. Hematoxylin–eosin, 100 ×.

sider that this is optic nerve tissue [3, 13], or connective or glial tissue [7]. Meanwhile, in the present experiments it was shown histochemically (the Miyagawa-Aleksandrovskaya reaction for glia, van Gieson) that the altered retina was adherent in the form of a glial film along the periphery of the connective-tissue band (Fig. 3).

This distinctive feature of detachment of the retina may be associated with the mechanical action of the hematoma, on the surface of which fibers of VB collapsed and condensed (Fig. 1), thereby exerting traction and displacing fibers of VB and its tracts toward this area [6], mainly if the hematoma is perilenticular in location. It can be postulated that later, with the development of hemorrhagic infiltration of VB and spreading of erythrocytes, films on VB connecting the perilenticular zone with the retina are formed, whatever the location of the hematoma, in zones of greatest mechanical obstacles, that is, around the lens, preretinally, and around the hematoma and hyaloid tract. Further liquifaction of the colloid structure of VB leads to even greater displacement of VB toward the axis of the eye, fusion together of zones with marked erythrocytic infiltration, and consequent detachment of VB [6, 16] and of the retina Fig. 1a, b), since condensation and contraction of VB are known to give rise to traction of the retina [1, 10, 14, 15].

It can thus be tentatively suggested that in the early phases of hemophthalmia detachment of the retina takes place mainly under the influence of the mechanical action of the altered VB. It may be reversible, considering possible regeneration of the hyaluronic acid of

VB and absorption of the blood. In the late phases and in the presence of large and recurrent hematomas, when regeneration is conspicuous, reinforcing the mechanical displacements which have arisen, the process becomes progressive and irreversible (Fig. 2). Another contributory fact is that the hematoma and, to a lesser degree, the peripapillary erythrocytic infiltration, induce organization from the optic disk and from the retina, with forward growth of fibrous tissue. All these changes lead to the specific structure of detachment of the retina, which is fused on both sides to a single central connective tissue band which runs from the optic disk toward the posterior capsule of the lens.

It is thus the medium surrounding the intravitreal hematoma (VB) which is responsible for the marked mechanical action of an intravitreal hematoma on tissue of the retina, leading to a detachment of the retina with a distinctive morphological structure, pathognomonic of hemophthalmia.

These observations may be important for clinical practice, for they indicate the need for early prophylactic measures (in the first 5-6 days) to prevent the mechanical action of an intravitreal hematoma.

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