THE LYMPHATIC APPARATUS OF THE HUMAN TESTICULAR TUNICA PROPRIA IN RELATION TO ITS RESORPTIVE FUNCTION

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The data relating to the lymphatic system of the tunica propria of the human testicle and the role played by it in the resorption of fluids and weighed suspensions, is quite scanty. There is only a single study by L. Allen [2]. In model experiments with human cadavera he demonstrated that injection of India ink into the cavity of the serous membrane of the tunica followed by light massage of the scrotum would, within a few minutes, result in entrance of this suspension into the lymphatic capillaries of the parietal layer of this covering. This author is of the opinion that lymphatic channels of the parietal layer play a major role in the absorption of fluids and suspensions present in the serous coverings of the testicle.

The work done by Allen deserves without a doubt the closest study even if many important problems having a direct bearing on the question in hand have remained either barely touched or altogether overlooked. It does not appear that he examined adequately the structure and especially the intra-serosal architecture of the lymphatic vessels lying within the serosal coverings of the testicle. There is no clarity in the mechanism leading to resorption of liquids and suspensions from the tunica into lymphatic channels. Finally, there has to be an experimental approach to the question of resorption by the tunica of hemorrhages.

All these enumerated problems furnished the object of the present investigation.

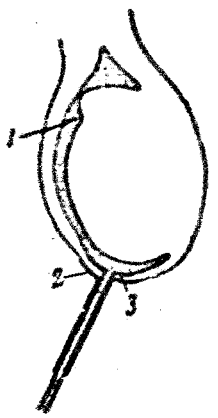

Fig. 1. Schematic representation of the cannulation of the serosal cavity around the testicle.

EXPERIMENTAL METHODS

In order to investigate the resorptive powers of the lymphatic vessels in the coverings of the human testicle, we employed cadavera of males, mostly of middle age, who had died from various types of trauma. In one experimental series we injected into the serosal cavity a suspension of India ink or Berlin blue (14 experiments), in another series — nucleated erythrocytes from hen blood which had been previously centrifuged repeatedly to separate the plasma and then weighed while in physiological saline suspension (10 experiments).

At the level of the lower pole of the testicle we opened all scrotal layers until the tunica propria was reached. The length of incision was 1-1.5 cm. In the wall of the tunica propria there would then be made a small opening (not over 0.5 cm), this leading directly into the cavity (Fig. 1, 1). Into this opening there was

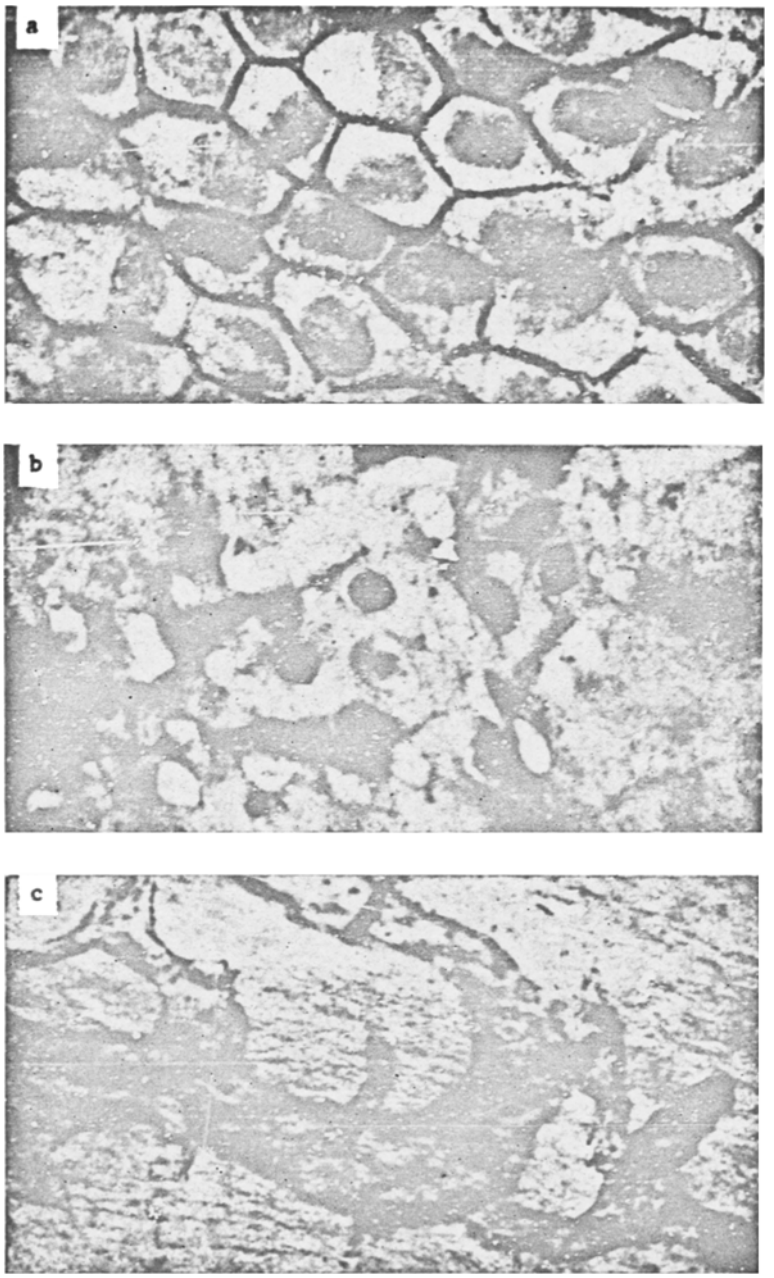

Fig. 2. Parietal layer of the tunica propria of human testicle. Into the space there had been injected 0.1% suspension of erlin blue (length experiment 5 minutes.

a) adsorption of dye particles at edges of mesothelial cells (nuclei stained with Ehrlich hematoxylin); immersion; b) window in basal membrane and nuclei of the lymphatic capillary endothelium; high power; c) the injected Berlin blue within lymphatic vessels of the deep net.

be introduced a glass cannula having a spherical rim 3 at the end. On this cannula was superposed cannula 2 having the same shape. In this situation the first cannula was fixed firmly to the wall of the cavity and the edges of the opening in the tunica were compressed between the rims of the two cannulas thus excluding the possibility that particles could enter the lymphatics through the incised tissues.

The inner cannula was then connected with a syringe or rubber bulb and the inside of the cavity was then rinsed out with physiological saline (to avoid clumping of suspensions) and only then would the indicator be carefully introduced until the level of the liquid in the cannula reached a predetermined level. Usually, not over 3 cc of suspension was injected.

Then the corresponding side of the scrotum was massaged, the tissues being alternately compressed and distended rhythmically by the fingers – all this varying the volume of the liquid that had been injected within the cavity of the coverings of the testicle. In this manner we attempted to duplicate the dynamics seen in life when the smooth musculature of the scrotum and the tunica of the testicle undergo rhythmic contractions [2, 5].

The experiments lasted from 2 to 30 minutes. At the end the cavity of the tunica propria of the testicle was fully opened and gently rinsed out with physiological saline, this removing the superficial particles of the indicator.

After fixing the tissues in 10% neutral formalin, longitudinal preparations were made from the entire visceral and parietal layers of the tunica propria. Depending on the aim of the microscopic analysis, the preparations were stained further with various reagents (iron trioxyhematin of Hansen, Ehrlich hematoxylin, aniline blue, fuchsin, etc.).

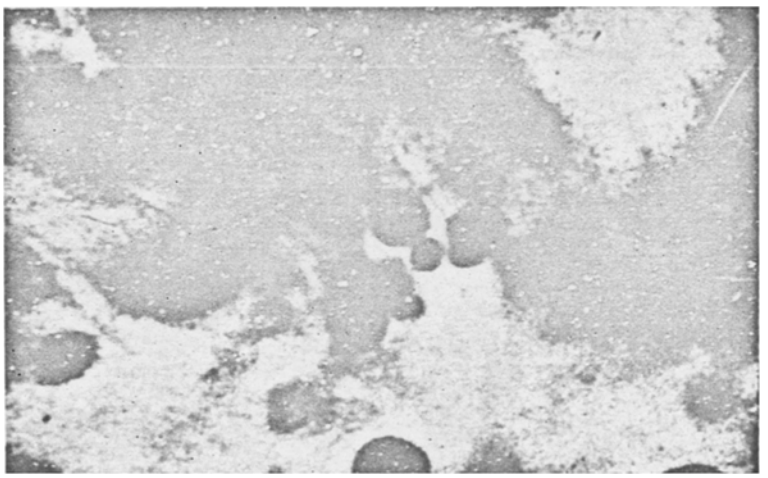

Fig. 3. Parietal layer of the human testicular tunica propria. Into the cavity nucleated hen red blood corpuscles were introduced (duration of experiment was 10 minutes). Erythrocytes can be seen within the lumen of the lymphatic capillary (Stained after Lepen and with Ehrlich hematoxylin). Immersion.

EXPERIMENTAL RESULTS

Even in experiments lasting 3-5 minutes, introduction of India ink or Berlin blue into the cavity of the tunica propria of the testicle would, as a rule, lead to intensive resorption of these indicators by the surface of the parietal layer while the visceral layer absorbed but traces of the dye. When the parietal layer was carefully scrutinized with the naked eye, it was possible to see that the lymphatic channels were becoming

injected leading to the formation of an extremely fine network.

Microscopic analysis showed that in the visceral layer there were only single particles scattered over the surface of the mesothelium. In cases when the integrity of the mesothelial cover had been destroyed one could observe a diffuse staining of the exposed limiting membrane. No penetration by the suspension into the depths of the visceral layer was ever demonstrated.

Within the parietal layer, in the areas corresponding to those identified by the naked eye as the lymphatic mesh, the mesothelial cells could be seen as being clearly outlined by dye particles lying mainly along the intercellular boundaries (Fig 2a). Numerous stomata are always visible here. These usually form small rings having the adsorbed dye on the rims or else assume the form of a completely stained node localized at the junction of several cells. Under the mesothelium are seen oval or round openings—the so-called windows of the basal membrane (Fig. 2,b). Through them are seen the dye laden lymphatic capillaries of the superficial net, while much deeper—the faint outlines of the vessels forming the deep net (Fig. 2,c).

The results of longer experiments (20-30 minutes) were identical with only the additional observation that the lymphatic nets of the parietal layer of the tunica propria of the testicle accumulated a large quantity of the suspension dye particles. Thus, our results agree with those of Allen demonstrating that coarse indicators (India ink, Berlin blue) penetrate readily from the cavity of the serosal testicular covering into the lymphatic channels of the parietal layer.

In the experiments in which chicken erythrocytes were introduced within the cavity of the serosal layers, the resorptive capacity of the lymphatics of the parietal layer was again clearly demonstrated. Within 10-15 minutes from the beginning of the experiment the erythrocytes had already penetrated into the superficial capillary mesh and the lymphatic channels leading from it. These avian nucleated erythrocytes are seen with especial clarity on total preparations prepared with benzidine (after Lepen) and then superstained with Ehrlich hematoxylin (Fig. 3). Individual erythrocytes can be seen directly under the mesothelium at the level of the limiting membrane. The visceral layer of the testicular serosal covering failed to show any erythrocytes in either the surface layer or in its depth.

This demonstrates that in regard to the formed blood elements—erythrocytes—the lymphatics of the parietal layer of the serosal cover form the only pathway of resorption from the cavity of this tunica propria. The very demonstration that erythrocytes can enter the lymphatics is, apparently, proof that hemorrhages into the cavity of the serosal sheaths of the testicle and scrotum absorb in this fashion. This presents a certain clinical interest as there has not been unanimity as to how a hematocele terminates. There arises the natural question: just how do particulate suspensions and the much larger erythrocytes forming a hydro- or hematocele penetrate into the roots of the lymphatic system existing in the parietal layer?

Let us examine the peculiarities of the histology and the intraserosal localization of the lymphatic vessels of the vaginal sheath of the testicle. In the visceral layer, as a rule, the lymphatics do not extend beyond the limits of the deep collagenous layer. However, in the parietal layer, because of the lesser collagenous framwork, there exists only the mesothelium and the limiting membrane separating the lymphatics from the serosal cavity. Both these layers within the parietal layer have their own anatomy of communication there being intercellular stomata within the mesothelial layer and windows within the limiting membrane. It is along these pathways that particulate matter leaves the cavity and proceeds to the lymphatic channels of the parietal layer.

Analogous adaptations for resorption of fluids and particulate matter exist in the diaphragmatic peritoneum, thoracic pleura and the pericardium where they may be called "hatches". Their significance in the mechanism of resorbing fluids from serosal cavities was grasped by I. M. Sechenov [5] who designated these structures as lymphatic suction pumps.

The demonstration of such "hatches" in the vaginal sheaths of the testicular coverings in man is not an accident. Their presence in all closed serosal cavities was predicted by I. M. Sechenov [5]. "In all probability, in due time such lymphatic pumps will be found in other serosal cavities (e.g., testicular serosal cover..), all these being completely enclosed cavities."*

* It is only in man, apes, and some marsupials that the cavity of the testicular serosal coverings becomes completely separated from the peritoneal cavity, this occurring as a result of the obliteration of the lumen of the connecting channel of the vaginal sheath. Other mammals have a system wherein there is maintained communication with the main peritoneal cavity and this outgrowth. The seminal serosal coverings in the animals we have studied (dogs, cats, rabbits, rams, boars, bulls) do not have these "hatches."

The resorptive function of the lymphatic apparatus of the serosal coverings we have investigated appears to be associated (as already conjectured by Allen) with the rhythmic contractions of the smooth musculature lying in the thickness of the parietal layer of given serosa, as well as in the smooth musculature of the scrotum as a whole.

Of course, the whole complex process of lymphatic absorption from the cavity of the testicular serosal layers does not depend on the musculature alone. Doubtless, in the living organism numerous biological factors are of the greatest importance, the neurohumoral influence being pre-eminently significant. Lymphatic capillary permeability, the biological acticity of its endothelium and the tone of the regional lymphatic nodes must play an important role. To solve the ensuing being raised, experiments must be done and the histo-physiologic material obtained from animals in this manner will require continued study.

SUMMARY

The lymphatic system of the parietal leaf of the testicular human tunica propria has been studied from the view point of the anatomy involved. Its peculiar absorptive power has been clearly demonstrated. The "hatches" and stomata absorb readily not only liquids but also particulate matter as large as avian erythrocytes.

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