CHANGES IN THE INTRAORGANIC LYMPHATIC SYSTEM OF THE RABBIT'S STOMACH AFFECTED BY BROWN-PEARCE TUMORS

V. N. Balashev

Department of Normal Anatomy (Head – Doctor of Medical Sciences V. N. Nadezhdin), Leningrad Public Health-Hygienic Medical School
(Presented by Active Member, Academy of Medical Sciences, USSR, M. F. Glazunov)
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Opinions concerning the existence of a lymph vessel system in malignant tumors are divided. Some authors [1, 8, 13] found lymph vessels in the tumor region. N. N. Petrov [14] described "lymph spaces without well defined walls" in tumors. Other authors, however, doubt or fully deny the existence of lymph vessels in tumors [10, 18 et al.].

In recent years a number of publications have appeared the authors of which described in detail the relation of the human lymphatic system to tumors [2, 3, 5, 6, 7, 17].

We set ourselves the task to study the morphological changes of the lymph vessels in a rabbit's stomach during the development and growth of a transplanted Brown-Pearce tumor in the wall of the organ.

EXPERIMENTAL METHOD

Our findings are based on the study of 80 preparations made from rabbits, stomachs, including 30 preparations made from animals carrying a transplanted Brown-Pearce tumor in the stomach wall. After laparotomy at a distance of 2 cm below the left costal arch, 0.5 cm^3 of a Brown-Pearce tumor suspension in normal saline were injected into the stomach wall. The animals were killed 15-45 days after the moment of transplantation. The lymph vessels of the stomach were injected with Herot's mass. After fixation in 10% formalin solution the preparations were dehydrated with alcohol and cleared in orthoxylene. The histotopography of the lymph vessels was studied on sections of 10-90 m thickness stained by van Gieson's method or with hematoxylin-eosin.

EXPERIMENTAL RESULTS

According to our findings the roots of the lymphatic system in the stomach of a healthy rabbit consist of networks of lymph capillaries in the submucosa, in the annular and in the longitudinal muscle layer. From these networks the lymph flows along the lymph vessels of the submucosa and the vessels in the muscle layer towards the lesser and greater curvature of the stomach.

We found considerable changes in the lymph vessels of the stomach if a Brown-Pearce tumor was present in the stomach wall.

In all cleared preparations we observed the formation of a dense spacially arranged network of lymph capillaries in the submucosa surrounding the tumor (Fig. 1) whereas in a healthy rabbit and in those stomach areas of the experimental animals which were remote from the tumor, the capillary network was arranged only in a single flat layer. The preparations showed that from the network in the submucosa in the immediate vicinity of the tumor, a great number of lymph capillaries irradiated into the submucosa and formed a dense network in the shape of a "case" surrounding the tumor. In the network situated in the submucosa at a distance of 1-2 cm from the tumor, blind processes from the wall of the lymph capillaries could be seen, which processes pointed toward the tumor.

If the Brown-Pearce tumor infiltrates the muscle layer from the submucosa, or if it grows in the muscle layer, the lymph capillary network in the muscle layer shows the following changes: here, just as in the submucosa, no lymph capillaries or lymph vessles could be seen in the central greater area of the tumor, whereas in the peripherical part of the tumors a few deformed residues of lymph capillaries and lymph vessels could be seen. In the immediate vicinity of the tumor a dense spacially arranged network or "case" of lymph capillaries could be seen which sur-

rounded the surface of that part of the tumor, which was situated within the muscle layer of the stomach (Fig. 2). This dense network of lymph capillaries in the muscle layer united with the similar network in the submucosa into a single "case" consisting of lymph capillaries surrounding the tumor.

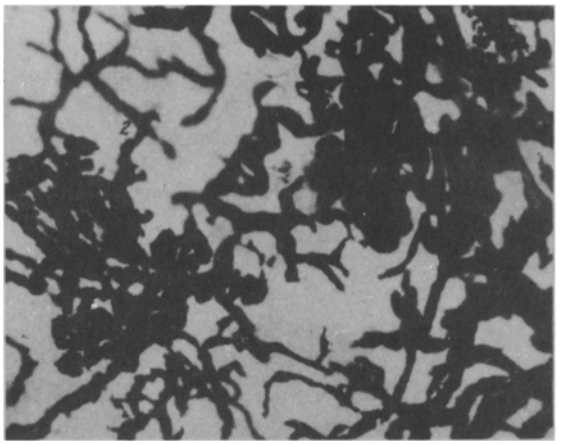

Fig. 1. The lymph capillaries with the spacially arranged network in the submucosa of a rabbit's stomach [1] over a Brown-Pearce tumor; the lymph capillaries of the flat network within the submucosa [2]. Microphotograph. Magnification: objective 1x, eyepiece 8x.

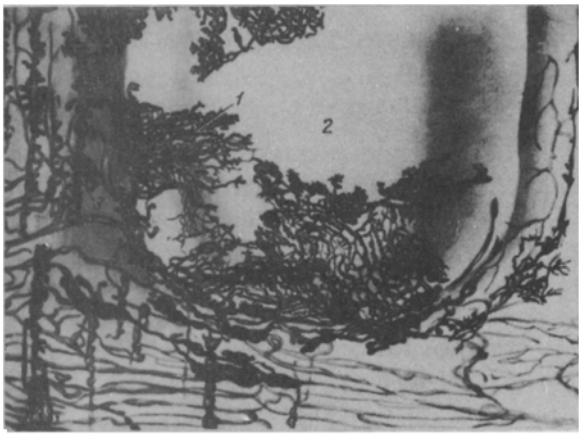

Fig. 2. The network of lymph capillaries forming a "case" round the tumor [1], the tumor [2] and "sprouts" from the wall of the lymph capillaries in the annular muscle layer [3]. Drawing from a section. Magnification: objective 2 x, eyepiece 8x.

The diameter of the lymph capillaries in the submucosa and muscle network changed in the vicinity of the tumor. Whereas the diameter of the lymph capillaries in a healthy rabbit varied between 0.015 and 0.055 mm, the spacially arranged network surrounding, in the case of cancer, the tumor in the submucosa and the muscle layer, consisted of irregularly anastomosing capillaries with a diameter between 0.015 and 0.3 mm.

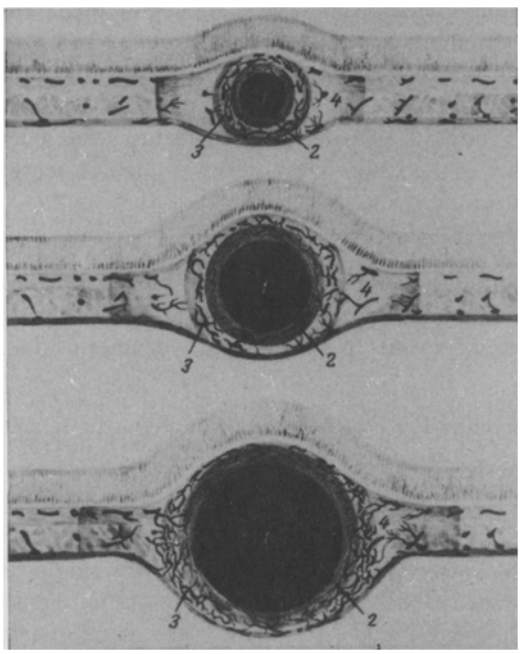

Fig. 3. Scheme illustrating the relation between the lymphatic system in the stomach wall of rabbits and the Brown-Pearce tumor. 1) First zone; 2) second zone; 3) third zone; 4) fourth zone.

The diameter of the stomach lymph vessels in a healthy rabbit varied between 0.125 and 0.275 mm. If, however, a tumor was present, the vessels which carried the lymph from the region of the tumor had a diameter between 0.075 and 0.36 mm. These vessels had sharp outlines and a great number of blind flask-shaped processes of 0.02 to 0.15 mm diameter.

We are inclined to agree with an earlier voiced opinion [2, 9] according to which the formation of a dense "case" consisting of lymph capillaries around the malignant tumor can be directly related to the metabolic changes which take place in the tissues affected by the tumor or surrounding the tumor. It is well known that an enormous quantity of lactic acid is formed in the tumor cells due to disorders in the carbohydrate metabolism and in addition, more products of protein metabolism accumulate than under normal conditions, due to the rapid breakdown of proteins which takes place in malignant tumors, [4, 20, 21]. In our opinion, the formation of metabolic products in quantities exceeding the normal level, requires a better drainage of the tissues, affected by the tumor or surrounding the tumor, and for this reason a dense lymphatic network develops around the tumor. The fact that the cancer cells compress and obturate the lumen of the lymph capillaries and lymph vessels which impairs the

free flow of lymph, is undoubtedly another important factor in the formation of the "case" consisting of lymph vessels around the tumor, as has been underlined by A. N. Skobunova [15].

In the muscle layer as well as in the submucosa, at a distance of 1-2 cm from the edge of the tumor towards the healthy tissue, an enormous number of blind processes, "growth processes," is formed from the wall of the lymph capillaries and lymph vessels which processes point towards the tumor (see Fig. 2). According to present opinion [12, 16, 19, 22, 23, 24] formation of new lymph capillaries in a healthy body takes place by the sprouting of pre-existing capillaries.

On the basis of our findings we are able to state that formation of new lymph vessels under pathological conditions also takes place by the growth of "sprouts" from the normally existing capillaries.

We followed up the relation between the lymphatic system of the stomach wall and tumors of different size. This relation between the growth of the tumor and the lymphatic system within the organ is illustrated in a scheme (Fig. 3). In our opinion, four zones can be discerned in the tumor region, each of which has its characteristic features with regard to its supply with lymph vessels. The first or central zone which includes the greater part of the tumor is deprived of lymph capillaries and lymph vessels. In the second zone which is situated around the periphery of the tumor, a few deformed lymph capillaries and lymph vessels can be seen which have preserved their connexion with the lymph vessels of the next or third zone. The third zone is situated in the immediate vicinity of the tumor. Here a dense network of lymph capillaries can be seen which form a "case" round the tumor. The fourth zone "the zone of primary reaction of the lymphatic system" is situated at a distance of 1-2 cm from the tumor. In this zone a great number of blind processes (sprouts) form from the wall of the lymph capillaries and lymph vessels, which sprouts point towards the tumor.

As the tumor grows, these zones continuously change their place. The first zone becomes larger and in consequence the second zone can be found where formerly the third zone had been situated; the third zone forms by the growth of the capillaries in the fourth zone which now, forming an anastamosis with each other, produce the lymphatic "case." Simultaneously a new fourth zone develops.

SUMMARY

The lymphatic system was injected with Herot's mass on 80 preparations of rabbit stomach (30 obtained from animals to which Brown-Pearce tumor was inoculated into the wall of this organ). The central tumor zones were devoid of lymphatic capillaries and vessels; as to the peripheral layers of the neoformation there were a few deformed capillaries which retained connection with the thick lymphatic network of tissues surrounding the tumor. New lymphatic capillaries developed by means of "growth buds" from the capillary and vascular walls.

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