

The Lymphatic System of the Spleen in the Calves

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Summary

The structure of the lymphatic network of the spleen was studied in calves. The lymphatic vessels were injected with latex and Gerota's mass. It was found that the superficial lymphatic network of the spleen consists of a single layer situated in the external layer of the fibrous capsule and projecting — when injected — into the space between the fibrous capsule and the serous coat. The network is dense and consists in lymphatic capillaries (of constant localization) and of small and large lymphatic vessels. The course of the small lymphatic vessels is marked by oval dilatations, and in the hilar region one or two lymph nodes are found. Attempts to inject the lymphatics branching from the superficial network and entering the interior of the splenic pulp were unsuccessful.

Introduction

The earliest work on the structure of the splenic lymphatic system was carried out in the second half of the 19th century by *Toms and Sappey* (cited 12, 15) and was concerned with the spleens of cows and horses. Further attempts at injecting the lymphatic system of the spleen were made by *Teichmann* (15), *Kyber* (8, 9), *Paulesco* (10) and *Baum* (1). This system was also studied by *Jäger* (6) and *Steger* (14).

Contrasting views on the structure of the lymphatic system of the spleen, and particularly of the superficial and deep lymphatic vessels may be classified as follows:

- 1) the spleen contains superficial and deep lymphatic vessels (1, 2, 5, 6, 7, 9, 10, 14),
- 2) the spleen contains only superficial lymphatic vessels (4, 15).

Most investigators appear to emphasize the existence of superficial as well as deep lymphatic vessels. *Harvey* (cited 2) found no deep lymphatic vessels in the spleens of some species of mammals, e.g. guinea pigs and monkeys. A smaller group of writers observed only superficial lymphatic vessels. In his treatise entitled "General anatomy and physiology of the lymphatic system", *Zhdanov* (17) does not discuss the lymphatic vessels of the spleen, in contrast to other lymphatic systems which are dealt with in great detail.

Experimental Observations

The purpose of this study was to describe the lymphatic system of the spleen, namely the superficial lymphatic network, its appearance, stratification, density, course of the lymphatic vessels, relations to superficial arterial and venous blood vessels and occurrence of lymphatics penetrating into the interior of the splenic parenchyma. Efferent lymphatic vessels leading to the neighbouring lymph nodes were not identified as only isolated spleens were submitted to study. Fourty calf spleens were studied. Injections were made with a 5-cc Record syringe and metal needles used for the Mantoux intracutaneous test either directly into the lymphatic vessels (which was quite easy) or into the splenic parenchyma. Latex and Gerota's mass, and in several cases 3% hydrogen peroxide solution, were used for the injections. Calf spleens displayed the most abundant lymphatic network.

This is in agreement with the observations of *Lauth, Katsuki and Steger* (cited 14, 15), who state that the lymphatic network in sheep and pig spleens is equally abundant. In man the lymphatic network of the spleen is poorly developed and difficult (12, 15) to inject. The superficial lymphatic network lies in the external layer of the fibrous membrane of the spleen; after injection it protrudes into the space between the fibrous and serous membranes. No lymphatic vessels were found in the serous membrane. The superficial network consists of only one layer even in the areas of its greatest density. Absence of lymphatic vessels in the serous membrane was demonstrated by injecting the splenic lymphatics which then appeared only in the fibrous membrane.

In the superficial lymphatic network one may distinguish: a) capillary lymphatic vessels, b) small lymphatic vessels with valves, c) large lymphatic vessels with a diameter greater than small lymphatic vessels. The meshes of the lymphatic network in calves are round, semicircular or oval. The smallest ones are formed by capillary lymphatics, increasing in size and shape in proportion to the caliber of the vessels forming them (Fig. 1, 2).

The capillary lymphatics of the superficial network occur at certain constant sites in the form of a band running on both surfaces of the spleen along its lower margin and along the anterior part of its upper margin. The internal edge of the band is somewhat frayed in places where the capillary lymphatics occupy a larger area of the diaphragmatic and visceral surfaces (Fig. 3). In the zone of lymphatic capillaries the lymphatic network reaches its greatest density, and any distinction between singly lymphatic vessels with the unaided eye is difficult. According to *Katsuki* (cited 2), injection of the lymphatic network on the diaphragmatic surface is more difficult. The network is less dense near the margin of the spleen, and single lymphatic vessels can be distinguished (Fig. 4). Small lymphatic vessels appear in the capillary zone, and each of them receives capillaries from a definite area. The number of small lymphatics is variable. Occasionally several lymphatic vessels, instead of one, drain the same area.

The small lymphatic vessels continue into large lymphatic vessels (the number of which is constant) what consist of two lymphatics on the diaphragmatic and two on the visceral surface of the spleen (Fig. 3). These vessels follow an arched course toward the hilus (Fig. 5). *Teichmann* (15) described several instances of large lymphatic vessels which, before entering the hilus, ran for a short distance in the parenchyma of the spleen. No lymphatics of this type were found in the material of this study. At times, instead of large lymphatic vessels, a bundle of lymphatics following the same course was present. *Katsuki* (cited 2) observed large numbers of large lymphatic vessels in calf spleens.

Elongated ampullar dilatations in the course of large lymphatics and small lymphatic vessels, resembling small lymph reservoirs, are suggestive, according to *Teichmann* (15), of glass beads inserted into a glass tube. Twenty dilatations may occur but their significance and function are unknown (Fig. 6). One or two lymph nodes were found in the hilus in three preparations in the course of the lymphatic vessels, especially those of the visceral surface. They never exceeded two in number. Such lymph nodes were described by several investigators (4, 11, 14), although they were usually encountered in large numbers (8-10). Their rare occurrence in this material may be due to the fact that the hili were usually damaged in the specimens submitted to study. The lymphatics near the hilus have large calibers reaching about 0.2 cm, rarely encountered in visceral lymphatic vessels. The lymphatic vessels are more superficial in comparison with the superficial arteries of the spleen in the fibrous membranes. The superficial arterial vessels are either single vessels emerging from the hilus and running in the direction of lower margin of

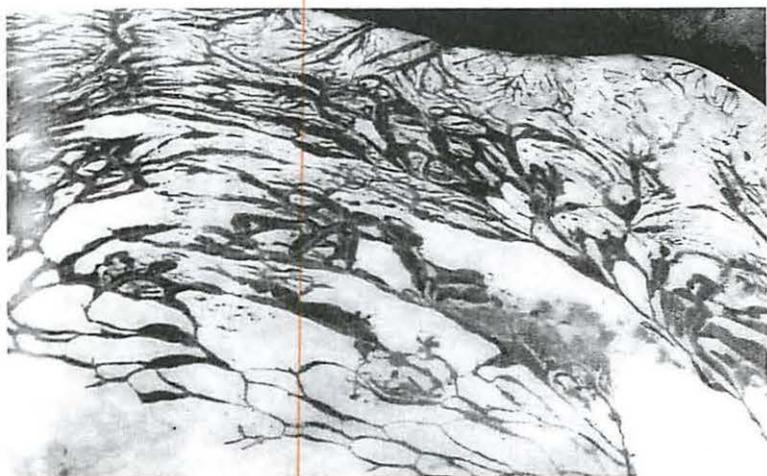


Fig. 1. Superficial lymphatic network on the visceral surface of the calf spleen. X ca. 14.

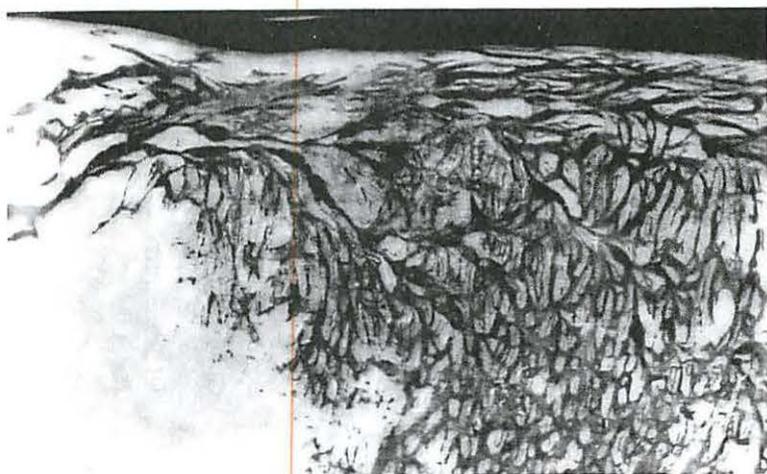


Fig. 2. Superficial lymphatic network on the diaphragmatic surface of the calf spleen. X ca. 14.

the spleen, or they are bundles of vessels emerging from under the serous membrane and spreading fanwise. The arterial vessels are usually covered by dense network of lymphatics, and the artery is sometimes accompanied for a short distance by a lymphatic vessel. The diameter of the superficial lymphatics is greater than that of the superficial arterial vessels. The present study has not confirmed *Slotwinski's* finding (cited 16) that superficially situated lymphatics and arterial vessels lie far apart, and that ramifications of the capillary lymphatic network always pass through the center of the meshes of the network of the capillary blood vessels. The lymphatics also lie more superficially than the venous blood vessels.

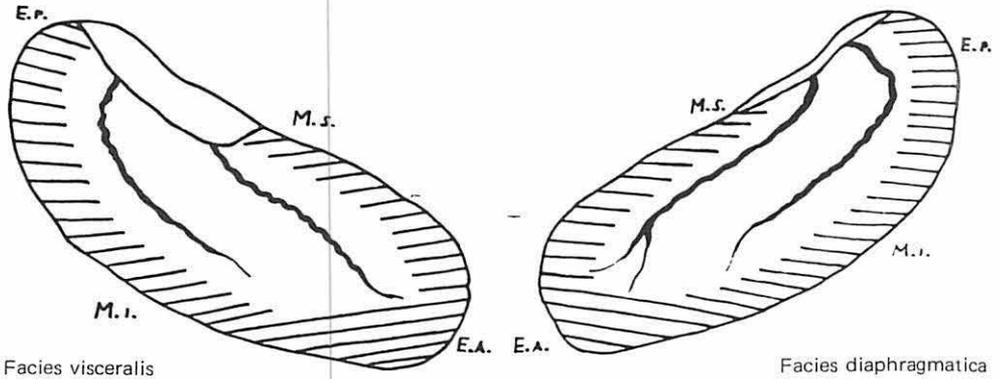


Fig. 3. Diagram of the superficial lymphatic network of the calf spleen. Lymphatic capillary region is marked by cross lines; the course of lymphatic trunks is also shown. E.A. — extremitas anterior, E.P. — extremitas posterior, M.S. — margo superior, M.I. — margo inferior.

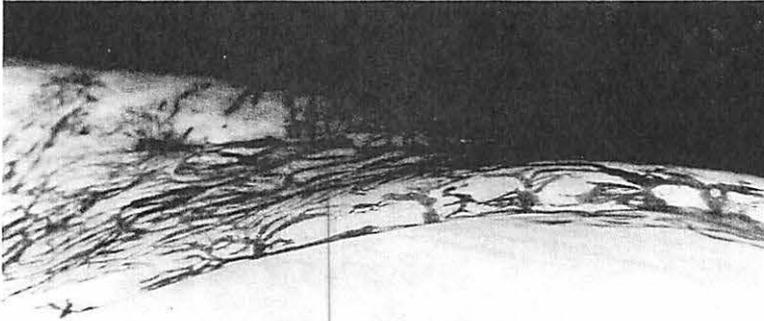


Fig. 4. Vessels joining the lymphatic networks of the diaphragmatic and visceral surfaces of the calf spleen. X ca. 6.

I was unable to inject in the calf spleen any lymphatic vessels passing from the superficial network into the parenchyma to join the deep lymphatic network. I attempted to demonstrate their presence by injecting the superficial lymphatics with latex and by making sections perpendicular and parallel to the surface of the organ. Although the deep lymphatic network of the spleen was not emphasized in this study some mention of them must be made. Certain investigators, e.g. *Jäger* (5) and *Biari* (12), found deep lymphatics only in pathologically altered spleens, e.g. in cancer of the spleen or in congested spleens. *Teichmann* (15), who denies the existence of deep lymphatic vessels in the spleens, states: „Ich weiß wohl, daß ich mich durch diesen Ausspruch schroff den Physiologen und Pathologen entgegenstelle, welche die Milz für eine Lymphdrüse halten, und daß dadurch das Wesen dieses Organes wiederum in eine rätselhafte Dunkelheit gehüllt

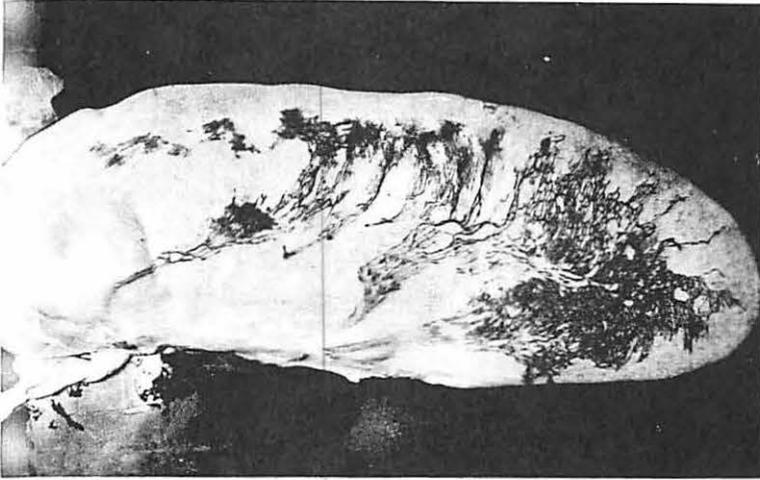


Fig. 5. General view of the superficial lymphatic network of the calf spleen.

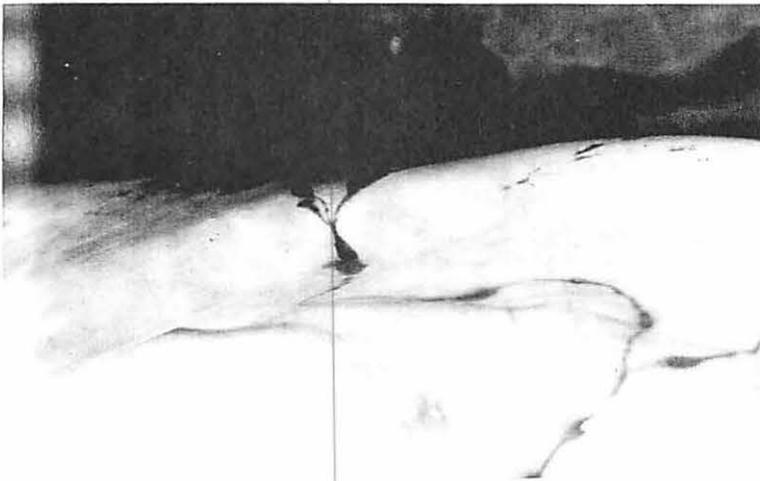


Fig. 6. Ampullar widenings of the lymphatic trunks of the calf spleen. X. ca. 10.

wird. Deswegen habe ich auch die Lymphgefäße in der Milz weit mehr gesucht als in manchen anderen Organen, allein jede Injektion bestärkte mich nur mehr und mehr in der eben ausgesprochenen Meinung."

Some authors, e.g. *Rouviere* (11), mention the appearance of anastomoses between superficial and deep lymphatic vessels only in the hilus. Such anastomoses were not detected during the present study.

Conclusions

1. The superficial lymphatic network of the spleen consists of one layer situated in the external layer of the fibrous membrane and protruding after injection into the space between the fibrous and serous membranes.
2. In the calf spleen the network is dense and made of lymphatic capillaries of constant localization, small lymphatic vessels, and two large lymphatic vessels on each surface of the spleen. Oval dilatations are found in the course of small and large lymphatics. One or two lymph nodes occur in the hilus.
3. The superficial lymphatic network of the spleen lies more superficially than the arterial and venous blood vessels of the fibrous membrane of the spleen.
4. Attempts to inject lymphatics branching from the superficial network and entering the interior of the splenic pulp were unsuccessful.

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