SOME OBSERVATIONS ON THE LYMPH AND BLOOD VESSELS OF THE RABBIT TRACHEA.

WITH PARTICULAR REFERENCE TO THEIR RÔLE IN THE PATHOGENESIS OF EXPERIMENTAL LOBAR PNEUMONIA.

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PLATES 5 AND 6.

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Blake and Cecil (1) in 1920 presented evidence to show that in lobar pneumonia the pathological process in the lung parenchyma is secondary to a lymphangitis in the submucosa of the main bronchi near the hilum. This point of view is supported by Winternitz, Smith, and Robinson (2) who, by the injection of India ink into the recently sacrificed rabbit’s tracheal submucosa, believed that they had demonstrated an unusually rich lymphatic network which was in communication with the lymphatics at the tracheobronchial junction, these in turn communicating with lymphatics leading to the parenchyma of the lung.

The injection method of Winternitz and his colleagues consisted of the insertion of a fine hypodermic needle beneath the mucosa of the trachea. With very gentle pressure on the plunger a rich plexus of vessels was uniformly outlined by the injected India ink. The photomicrographs which accompany this paper demonstrate a profuse anastomotic network of ink-filled channels in the submucosa of the trachea.

In the course of experiments to determine the routes of absorption of various dyes from the pericardial cavity we attempted to outline the peritracheal lymphatics and to repeat the injections reported by Winternitz, Smith, and Robinson.

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Experimental Methods and Data.

Rabbits were killed, with an occiput blow. The trachea was then bluntly freed from the surrounding tissues. An incision was made anteriorly in the midline of sufficient length to allow for the injection procedure. A fine 27 gauge platinum hypodermic needle attached to a 2 cc. syringe containing either full or half strength Higgins' India ink was carefully inserted beneath the tracheal epithelium. With gentle pressure on the plunger a rich plexus of ink-filled vessels immediately sprang into view. It was important to avoid holding the trachea on the stretch for this impeded the filling of the channels. With proper pressure and a few changes in the site of injection the entire submucosa of the trachea was outlined by the short, stubby, richly anastomosing ink-filled channels (Fig. 1).

In the midst of one of these injection experiments it was noted that some of the dye was filling a vessel about 1 mm. in diameter lying in the supporting tissue, parallel to and to the left of the trachea. Another vessel filled with ink, smaller than the first, lay in the loose tissue to the right of the trachea. With the aid of the dissecting microscope the smaller of the two channels was traced into the peritracheal tissue, whereas the larger was found to run along the entire length of the trachea, receiving branches from that organ and emptying into the superior vena cava just before this vessel entered the right auricle. Particles of ink were found in the superior vena cava and the right auricle.

Another preparation was made in the following fashion. The rabbit was killed and the trachea slightly freed from its surrounding structures. The vein parallel and to the left of the trachea, referred to above, was identified, tied towards the heart, and injected towards its origin. In a few moments the rich plexus of vessels in the tracheal submucosa became partially filled with the India ink and many veins from the angle of the jaw to the clavicle became stained with the dye.

In a third experiment the rabbit was sacrificed by an occiput blow, the entire trachea removed and slit in the anterior midline. The preparation was then inspected under the dissecting microscope. A plexus of short, stubby, richly anastomotic blood vessels ramified in the submucosa. These vessels were identical with the network which had been injected with ink in the previous experiment and were similar to the channels described by Winternitz and his coworkers as lymphatics.
The hypodermic needle was then inserted into the submucosa and an attempt was made to demonstrate the presence of lymphatics as distinct from the blood vessels. With the aid of a dissecting microscope it could easily be seen that the ink granules entered the meshwork of vessels and pushed the blood cells before them. Repeated attempts to inject lymphatics always met with the same results although five rabbits were used and each trachea subjected to many injections under the microscope.

Pieces of normal rabbit trachea and of tracheae injected with India ink were fixed in Zenker's and stained with Giemsa.

Examination of the normal trachea demonstrated that the vascular arrangement is of an unusual order (Fig. 2). An extremely rich supply of very thin walled anastomosing blood vessels ramifies in the submucosa. In some sections a single vessel extends about one-fourth the circumference of the trachea. Many little outpocketings designating the junction of tributaries are observed in these larger channels. The walls of these vessels consist of a single layer of endothelial cells with a very delicate connective tissue stroma which is best brought out with Mallory's aniline blue stain. If these thin walled vessels are not filled with blood it is very difficult to distinguish them from lymphatics. It is possible, however, to identify lymphatics and the submucosa but they are of very small calibre, relatively few in number when compared with the blood vessels, and the supporting connective tissue for the latter is slightly more prominent than that for the lymphatics.

The large bronchi contain the same arrangement of blood vessels.

Sections through the trachea which have been injected with India ink present one of two pictures. In the one the red and white cells of the vessels have been completely replaced by ink particles and photomicrographs of these regions resemble those described by Winternitz, and his collaborators, as being ink-filled lymph channels. In the other group of sections, ink granules and blood cells may be seen mingled in the same vessel (Fig. 3).

The human trachea\(^1\) was examined to ascertain whether there existed in the submucosa a vascular supply comparable to that

\(^1\) We wish to thank Dr. Charles Connor of the Pathology Department of the Peter Bent Brigham Hospital for his aid in obtaining this material.
found in the rabbit. The thickness of the mucosa made it impossible to study the vascular channels under the dissecting microscope. Nevertheless, strips of the normal human trachea were subjected to the technique of a blind stab and injection into the submucosa. The results derived from this procedure were unexpectedly satisfactory. Grossly it could be readily seen that two independent types of vessel plexuses existed. Sometimes the one type and sometimes the other was injected. One plexus was finer than the other. Microscopic examination of sections prepared from the injected areas showed these channels to be lymphatics which are smaller and less numerous, than the blood vessels (Fig. 4).

The second type of plexus injected is made up of small blood vessels. These vascular structures bear no resemblance to the rich blood supply found in the rabbit trachea.

SUMMARY AND CONCLUSIONS.

1. Winternitz, Smith, and Robinson have offered as experimental evidence in support of the lymphatic path of infection in lobar pneumonia, a series of injection experiments of the rabbit's tracheal submucosa.

What these investigators supposed to be lymphatics are shown by us to be an unusual type of venous supply consisting of short, wide, and richly anastomosing vascular channels.

2. There is little homology between the structure and distribution of the lymph and blood vessels in the human and rabbit trachea.

3. Injections of pneumococci by the tracheal route to produce lobar pneumonia in the rabbit include an intravenous administration of these organisms when the mucosa is pierced or injured.

BIBLIOGRAPHY.

EXPLANATION OF PLATES.¹

PLATE 5.

Fig. 1. Blood vessels of the submucosa of the rabbit's trachea injected with India ink. Preparation cleared by the method of Spalteholz.

Fig. 2. Blood vessels in the submucosa of the rabbit trachea.

PLATE 6.

Fig. 3. Blood vessels in the submucosa of the rabbit trachea partially filled with India ink.

Fig. 4. Submucosa of the human trachea. The lymphatics are filled with India ink.

¹ We are indebted to Dr. S. B. Wolbach for the photomicrographs.
(Seegal and Seegal: Lymph and blood vessels of rabbit trachea.)
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