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SOME DATA CONCERNING THE PROBLEM OF INTERCONNECTIONS BETWEEN INTRAADVENTITIAL SPACES OF THE PULMONARY ARTERIES, AND THE LYMPH VESSELS

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It has been observed that in dogs the pulmonary lymph congestion induced by the ligation of the thoracic duct, the right lymphatic trunk and the regional lymph nodes was followed by pulmonary oedema. Histology revealed oedema of the intraadventitial spaces around the branches of the pulmonary artery in three cases. Since neither injections nor a "suction" of the lung were performed in the experiments, the observation was regarded as a direct proof of the existence of these spaces [2].

The intraadventitial spaces were first described by IVANOV [5, 6]; according to this author they surround the rami of the pulmonary artery in the shape of fenestrated sheaths, are bounded by a peculiar fibroblastic trabecular frame and form part of the external coat of blood vessels. IVANOV termed them "lymphoid spaces" and claimed the existence of a direct communication between them and the lymphatic system.

SHDANOV [14] regards intraadventitial spaces as artefacts, while CORDIER and NGUYEN HUU [1], MARCHAND [9], HAYEK [4] and KISS [7] accept their existence. TAMÁSKA and HARSÁNYI [13] suggested that in man the intraadventitial spaces are preformed lymphatics; whenever they found such spaces filled with blood or transudate, their walls displayed an endothelial lining.

GROSS [3] claims the perivascular spaces to be no normal anatomical structure but a pathological phenomenon, namely perivascular oedema; he was unable to demonstrate such spaces in the lung of aseptically raised animals and therefore refuses to regard them as lymphoid spaces.

It has been also observed [2] that the fluid filling the intraadventitial spaces, the lymph contained in dilated lymphatics and the pulmonary oedema fluid had identical staining properties.

In the paper referred to [2], no definite view could be taken regarding the connection between intraadventitial spaces and the pulmonary lymphatics. That the spaces are no true periarterial lymphatics seemed to be shown by the absence of endothelial lining, the presence in the lumen of transversal con-

nective-tissue fibres as are never encountered in lymph vessels, and the occasional presence of endothelially lined true lymph capillaries in the immediate vicinity of the spaces under review. In one of the cases, a lymph capillary tightly adhering to the intraadventitial space was examined in serial sections. "It seemed as if the endothelial boundary between the intraadventitial space and the lymph capillary had disappeared in a certain plane and if — in harmony with IVANOV's theory — there existed a direct anatomical communication between the two systems."

The question concerning the existence or non-existence of an intercommunication could nevertheless not be decided and the conclusion drawn from observations was that the intraadventitial spaces were not artefacts, that there was circulation in them, and that in pulmonary oedema they were filled with oedema fluid. "While the existence of a functional communication between the intraadventitial spaces and the pulmonary lymphatics by way of diffusion seems to be proven, the question of an anatomical communication needs further elucidation."

The present studies had the purpose to settle the question left open in 1954, in other words to determine whether there exist open lymph capillaries in the intraadventitial spaces, capillaries starting without an endothelial boundary. The existence of such formations would disprove the theory accepted since MACCALLUM [8] that lymph capillaries begin invariably in the shape of glove-fingers, like cul-de-sacs.

We used 20 mg Wistar rats in the present experiments. By way of subcutaneously injecting 300 mg of adrenalin, pulmonary oedema was induced. Decapitating the surviving animals an hour after the injection, we opened their thorax and fixed their entire cadaver in hot formalin. After fixation, we removed the lungs together with the trachea, cut them off at the main bronchi, bisected them longitudinally and embedded the half lungs in one piece. Serial sections showed the following picture.

All animals had developed pulmonary oedema of approximately the same gravity; the alveoli were filled with oedema fluid homogeneously staining with eosin. There was oedema also peribronchially.

Periarterial oedema was of variable intensity. While the smaller and larger arteries were completely surrounded by oedema in some animals (Figs. 5 and 7), in others oedematous intraadventitial spaces were seen only around a limited portion of the vessels (Fig. 8). The fluid of these oedemas stained usually as the oedema filling the alveoli.

In some instances, we found endothelially lined and sharply circumscribed lymph vessels in the oedematous intraadventitial spaces (Figs. 5 and 6). The wall of these vessels proved to be impregnable with silver. In contrast with the original observation, the intraadventitial spaces and the fluid in the lymphatics often displayed considerable differences in staining, the contents of the lymphat-

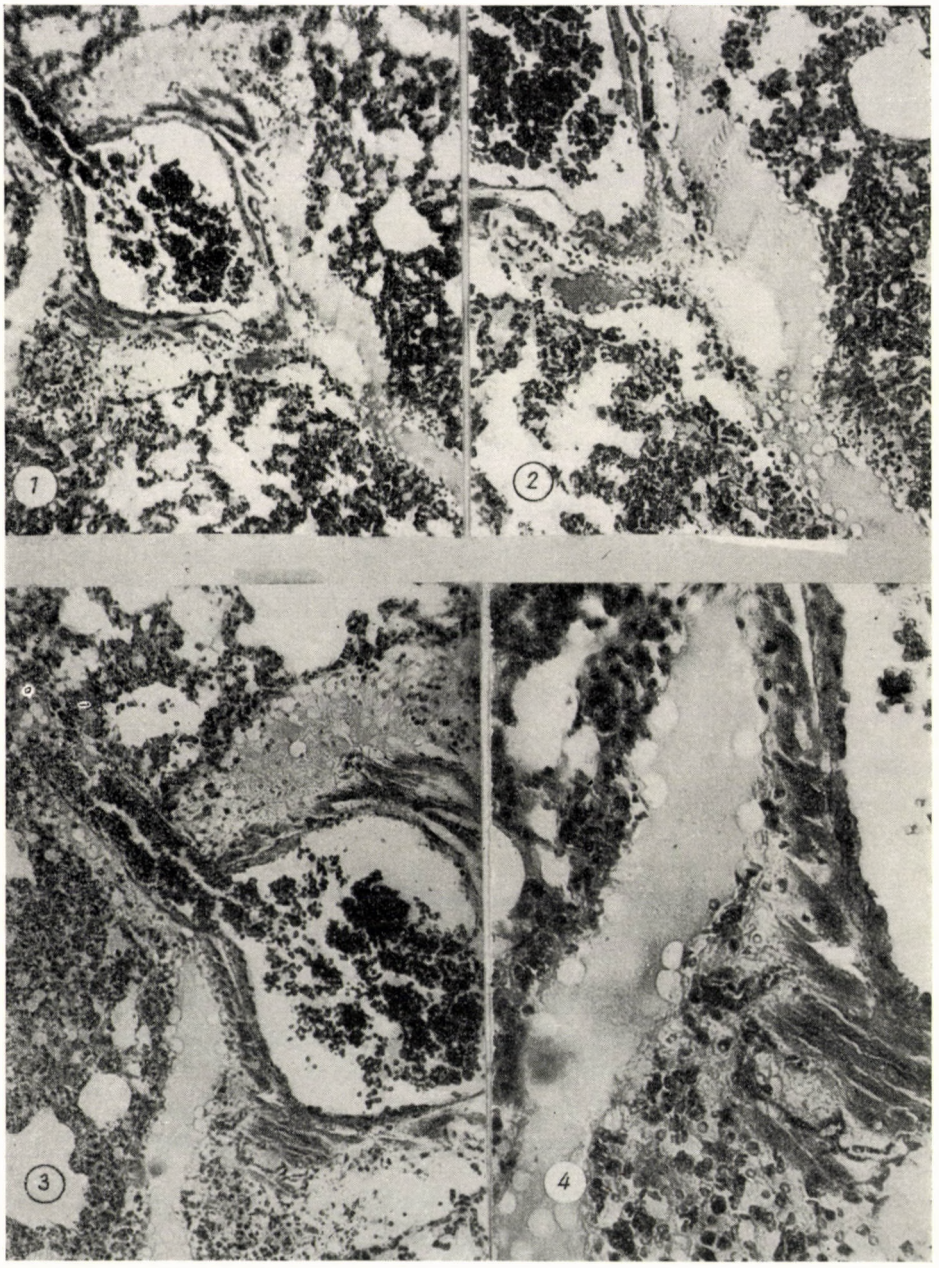

Fig. 1—4

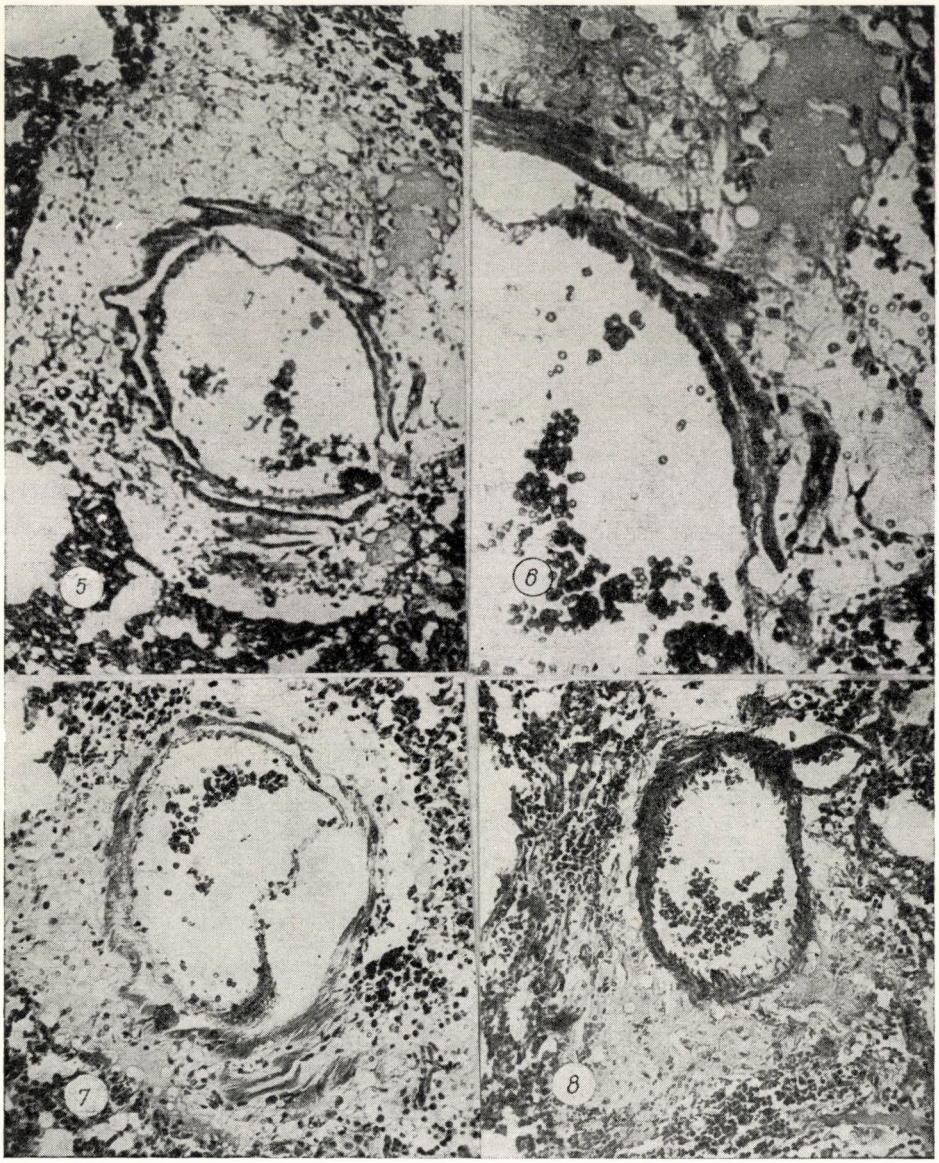

Fig. 5—8

ics took the stain more intensely than the surroundings. In no case did we see intraadventitial spaces lined with endothelium.

Examining some individual intraadventitial spaces (or rather particular branches of the pulmonary artery) in serial sections, we observed in a number of cases lymph vessels arising in the intraadventitial spaces as goblet-like open

figures (Figs. 1 to 6). At higher levels of the intraadventitial space, the lymph vessels appeared as formations with regular argyrophile walls. Especially in longitudinal sections where the lymph vessels could be followed along a longer course, there was a gradually increasing concentration of the lymph as revealed by its more and more intensive staining (Figs. 1 and 2).

Discussion

Our experimental results seem to substantiate IVANOV's assumption [5, 6] of a direct communication between the intraadventitial spaces and the system of lymphatics with endothelial lining. We cannot accept SHDANOV's suggestion [14] that the intraadventitial spaces are artefacts. The method used in our experiments has excluded that possibility. We have essentially confirmed the correctness of the findings of GROSS [3], CORDIER and NGUYEN HUU [1], MARCHAND [9], HAYEK [4], KISS [7], as also that of our earlier observations.

Worthy of especial mention is our observation that the intraadventitial spaces contain lymph capillaries which arise as open, goblet-like figures. As far back as the last century did RECKLINGHAUSEN [10] claim that lymph capillaries were provided with stomata through which they could freely communicate with the interstitial space. Instead, MACCALLUM's theory [8] has been accepted, according to which lymph capillaries always start in the shape of finger-gloves or plexuses, in other words as closed formations sharply separated from the surrounding tissue. On the other hand, PALAY and KARLIN [11] recently demonstrated by electron microscopy stomata in the central chyle capillaries of the intestinal villi . . . This observation, together with our present results, seems to indicate a revision of the present concept regarding the interrelation between lymph capillaries and the interstitial space.

Summary

In rats with pulmonary oedema induced by means of adrenalin injection, intra-adventitial spaces filled with oedema fluid have been demonstrated around the branches of the pulmonary artery. The spaces were in direct communation with the system of lymph vessels lined with regular endothelium.

In some instances, open lymph capillaries — arising in the form of goblets — have been found within the intraadventitial spaces.

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ОБ ИНТРААДВЕНТИЦИАЛЬНЫХ ПРОСТРАНСТВАХ ЛЕГОЧНЫХ АРТЕРИЙ И ИХ СВЯЗИ С ЛИМФАТИЧЕСКИМИ СОСУДАМИ

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В отёке легких вызванном на крысах инъекцией адреналина были выявлены около разветвлений легочной артерии наполненные отёчной жидкостью интраадвентициальные щели. Между этими щелями и системой выстланных регулярным эндотелием лимфатических сосудов существует непосредственная связь.

В пределах интраадвентициальных пространств наблюдаются местами чашевидно открыто начинающиеся лимфатические капилляры.

ÜBER DIE FRAGE DES ZUSAMMENHANGES DER INTRAADVENTITIELLEN RÄUME DER LUNGENARTERIEN MIT DEN LYMPHGEFÄSSEN

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Bei Ratten wurde durch Adrenalinjektion Lungenödem hervorgerufen. Um die Lungenarterien konnten mit Ödemflüssigkeit gefüllte intraadventiellen Spalten und zwischen diesen Spalten und dem System der mit regelmäßigem Endothel ausgekleideten Lymphgefäße eine direkte Verbindung beobachtet werden.

Innerhalb der intraadventitiellen Räume waren stellenweise kelchförmig beginnende Lymphkapillaren zu sehen.

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