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The Migration of Lymphocytes across the Vascular Endothelium in Lymph Nodes: A Scanning Electron Microscopic Study

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Summary

Endothelial cells of Postcapillary Venules (PCV) and the passage of lymphocytes through the wall of PCV were investigated with Scanning Electron Microscope (SEM) in mesenteric lymph nodes of rats. Individual endothelial cells of PCV in the lymph node did not have flat surface or were not typically cubic, but swelled at the central part assuming a foot ball-like shape. Circulating lymphocytes are considered to migrate into lymphatic tissues through the wall of PCV from the blood stream. Two hypotheses, inter-endothelial cell passage and intra-endothelial cell passage, have been proposed. The three-dimensional studies on lymphocytes passing the wall with SEM confirmed that migrating lymphocytes pushes their way through the intercellular space with pressing the adjoining endothelial cells from beginning to end, supporting the former hypothesis. Invasion of lymphocytes into endothelial cells were not observed.

Thome first reported a light microscopic study on the PCV, though this anatomical term was first used by *Schultze*. Thereafter, many investigators have given attention to the peculiar structures from the morphological, immunological, and pathological point of view. PCV was characterized by the peculiar structures consisting of high endothelial cells which were cubic in cross section and by the presence of many lymphocytes in the lumina and endothelium. In our study stress was placed on the observation about the three-dimensional structure of PCV and the passing mode of circulating lymphocytes by SEM.

Materials

Male Wistar rats weighing 250–350 g were used.

Observations and Discussion

Most endothelial cells were 7 to 14 μ major axis, 3 to 6 μ in minor axis, and 5 to 8 μ in height. They were high and swelled out into the tubular lumina at the center, and were lower with nearing the periphery (Fig. 1).

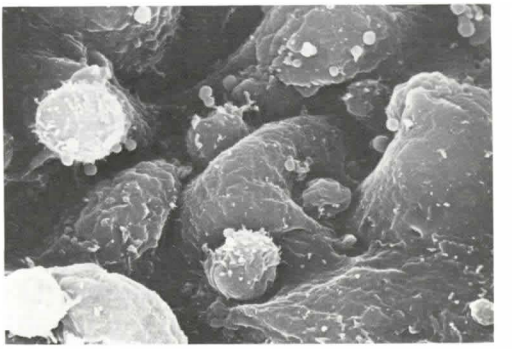

Fig. 1 SEM picture of the luminal surface of PCV. Lymphocytes stick between neighboring endothelial cells. Noticeably 4 or 5 lymphocytes invade central one endothelial cell. Granular processes are found on the free surface of endothelial cell. x3800

Wenk et al. reconstructed the three-dimensional properties of high endothelial cells of PCV in the lymph node through observation of serial sections with TEM. However, these can not give all investigators satisfaction. The height and shape of endothelial cells are not always uniform. At the invasion of lymphocytes the endothelial cells continuous to them were deformed by their pressure. Endothelial cells may restrict the loss of cytoplasm by adapting their external shape to the form of lymphocytes on the one hand, and assist the movement of lymphocytes on the other hand. Umetani

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suggested that endothelial cells of PCV of rabbit tonsils had marginal processes which might make the passage of lymphocytes easy by constraction. However, bundle of microvilli corresponding to marginal processes were not found in our SEM study of Endothelial cells of rats mesenteric lymph nodes.

Marchesi and *Gowans* first investigated the state of lymphocytes passing through the wall of PCV and reported that lymphocytes first entered endothelial cells from luminal surface, traversed the cytoplasm, and then got out to the basement membrane. In opposition to their hypothesis, some investigators insisted that lymphocytes might move to lymphatic parenchyma from the blood stream through intercellular spaces and that it was impossible to consider the intracellular passage of lymphocytes. In the present SEM study the surface of the inner spaces could be observed extensively the special relationship between lymphocytes and endothelial cells in the spaces which have been impossible to obtain with TEM could be taken in one view. Almost all lymphocytes in PCV existed in wide furrows between endothelial cells and no evidence suggesting the passage of lymphocytes through endothelial cells was obtained in observation of either surface or cracked section. A lymphocyte first sticks in a furrow, then gradually invades into deeper part with change of its end into wedge-shaped one as shown in Fig. 2, adheres to the neighboring cells, and moves on under pressing them. Another valid evidence obtained from the present SEM study for the intercellular migration hypothesis is that a few lymphocytes adhered to an endothelial cell very frequently. It is difficult to consider that a few lymphocytes can pass through the cytoplasm of an endothelial cell, even if one lymphocyte could do so.

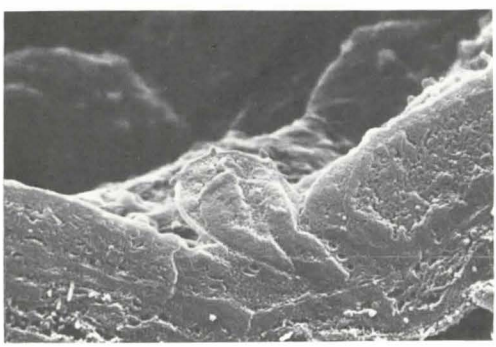

Fig. 2 Picture of PCV by Epoxy-resin cracking method. The advanced tip of a lymphocyte becomes thin and wedge-shaped and is entering into a narrow gap by pushing the neighboring cells x11 000

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