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A TUBULAR STRUCTURE IN THE ENDOTHELIAL CELLS AND PERICYTES OF HUMAN CAPILLARIES*

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There have been relatively few studies concerned with the ultrastructure of the human vascular system (1, 2). Most studies, rather than dealing with the morphologic aspects of the vessels, have dealt with the functional aspects of inflammation (3, 4). In studying a number of sections of human skin it was noted that a tubular structure was frequently encountered in the endothelial cells and pericytes of human capillaries. A recent report by Weibel and Palade (5) called attention to this structure and in particular related it to arterial endothelial cells. Because this structure is regularly found in large numbers in human skin capillaries it was felt that this observation should be recorded.

MATERIALS AND METHODS

Skin was obtained by punch biopsy from the flexor surface of the forearm of Caucasian patients. The tissue was immediately fixed in buffered 1 per cent osmium tetroxide and embedded in Epon 812. Sections were cut with glass knives and examined with an RCA EMU 3-G electron microscope. The sections were contrasted with uranyl acetate and lead citrate.

OBSERVATIONS

In human skin the capillary endothelium is supported by a basement membrane and at times is surrounded by pericytes which also are enclosed by the basement membrane (Fig. 1). The endothelial cells are characterized by numerous pinocytotic vesicles along their plasma membrane and possess typical mitochondria, Golgi vesicles, mitotic figures, dense bodies and both a rough and smooth surfaced endoplasmic reticulum. Cytoplasmic filaments are also present. The pericytes normally lie adjacent to the endothelial cells but in vessels near sites of inflammation the pericytes are found to lie some distance from the endothelial cells, although still enclosed by the basement membrane. When adjacent to the endothelial cells the pericytes are elongated but when located away from the vessel they tend to be round. Mitotic figures are also found in the pericytes.

Of particular interest are the numerous rod-shaped, tubular structures which are found in large numbers in both the endothelial cells and the pericytes of human skin capillaries (Figs. 1–4). The structures are located within the cytoplasm of these cells and are quite osmiophilic. They are approximately 0.2 μ in diameter and up to 1.0 μ in length. They are present throughout the cytoplasm and are often found in relation to the smooth surfaced vesicles of the endoplasmic reticulum or the numerous pinocytotic vesicles of the endothelial cell. In cross-section, depending on the plane of section, they are either oval or round. A distinct membrane encloses the structure and appears to be continuous. The lumen of the body contains numerous tubules which are also enclosed by a definite membrane and lie parallel to the long diameter of the structure (Figs. 2–4). The tubules are from 100 to 190 Å in diameter and their number within each of the bodies is variable. As mentioned previously, the rod-shaped structures were found in the cytoplasm of both the endothelial cells and the adjacent pericytes.

DISCUSSION

Rod-shaped structures were recently described in the endothelial cells of small arteries in the lung of man and rat as well as in the endothelium of *Amblystoma* skin vessels (5). The structures reported here, and found in large numbers in the capillaries of humans, are apparently the same or closely related. In skin vessels they are found not only in the endothelial cells but also, as reported here for the first time, in the pericytes. Because of the regular occurrence of this body in the vascular endothelial system of man and rat, Weibel and

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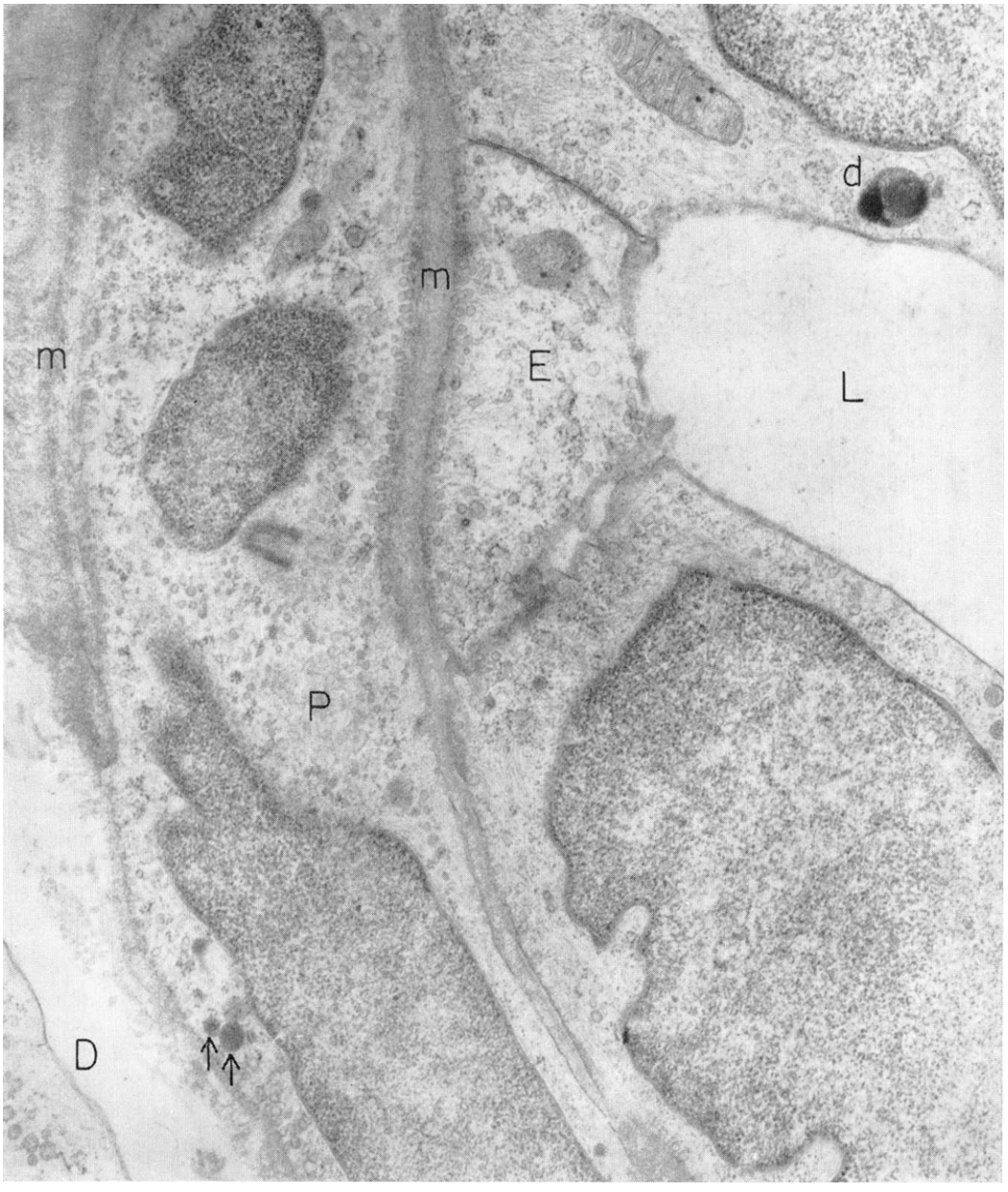

FIG. 1. An endothelial cell (*E*) and pericyte (*P*) of a small human skin capillary. Several rod-shaped bodies are found in the pericyte and are pointed out by the arrows. *d*, dense body; *D*, dermis; *m*, basement membrane; *L*, lumen. × 20,930.

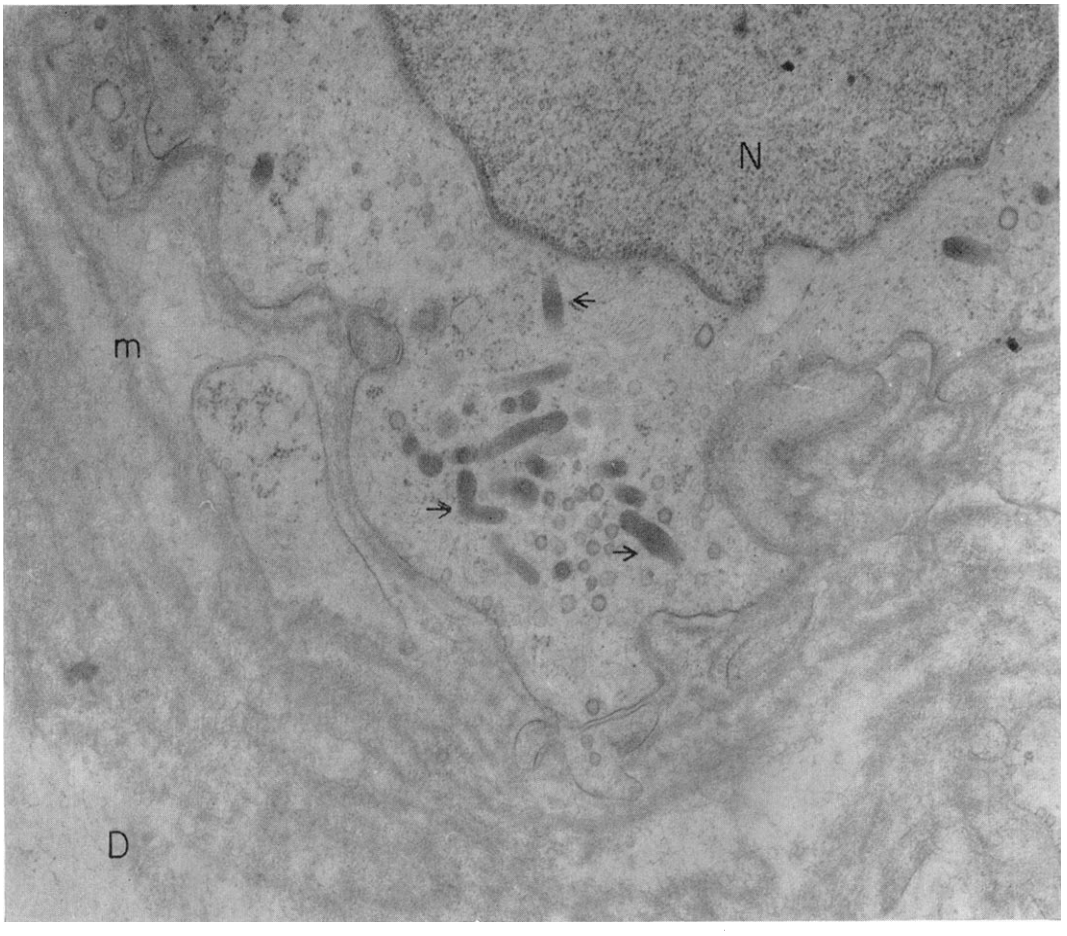

FIG. 2. Transverse and cross sections of the tubular bodies (see arrows) are located near the nucleus (*N*) of an endothelial cell. Note the close relationship to the many small smooth-walled vesicles. *D*, dermis; *m*, basement membrane. × 23,100.

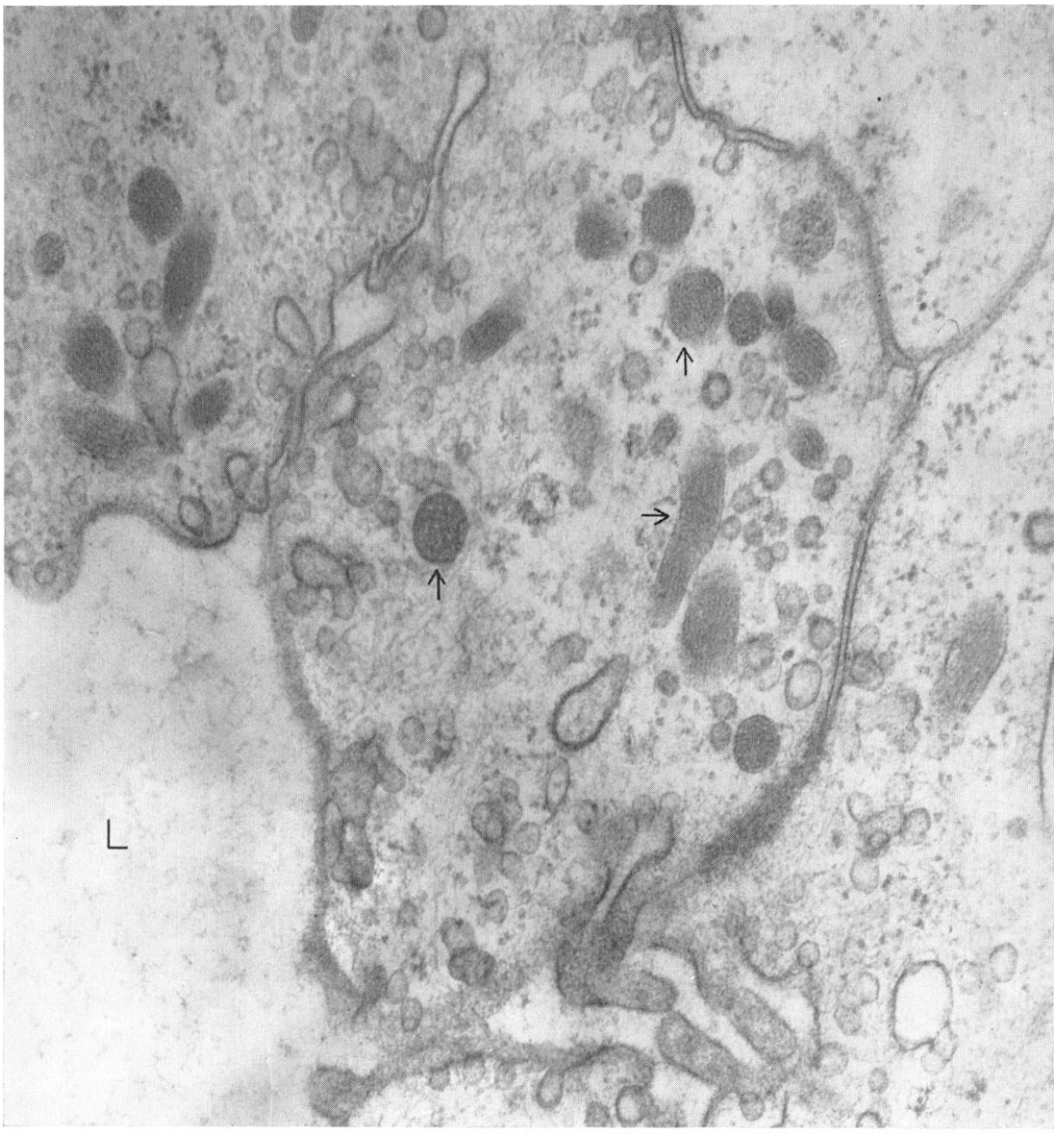

FIG. 3. The characteristic ultrastructure of these rod-shaped bodies (arrows) is shown to better advantage at this higher magnification. They have a definite limiting membrane and are closely associated with the smooth-walled vesicles of the cell. *L*, lumen. × 54,201.

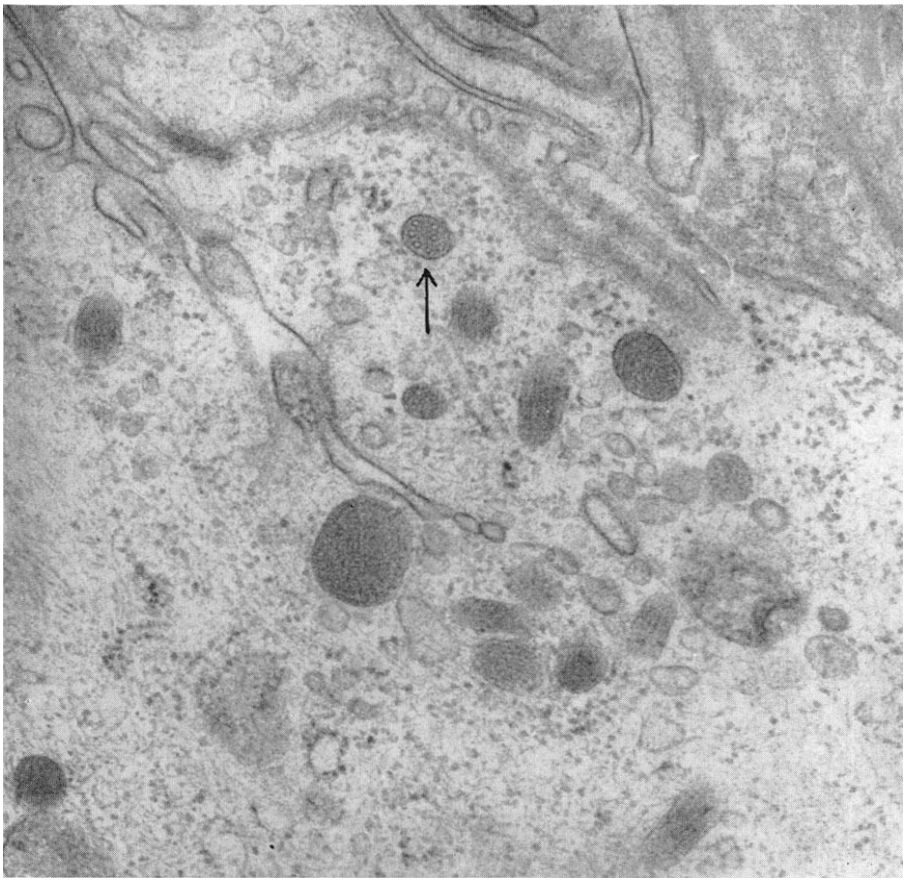

FIG. 4. A definite tubular component is seen when the rod-shaped bodies are cut in cross-section (see arrow). Each small tubule has a limiting membrane and is separated from its neighbor by a matrix material. The rod-shaped bodies are more osmiophilic than the surrounding cytoplasm but the small tubules within the "body" have a relatively clear lumen. × 46,980.

Palade (5) were of the opinion that this structure must have some functional significance, the exact nature of which is not yet known. In human skin these rod-shaped bodies are related to the pinocytotic vesicles of the cells and thus may serve some function in the transport of material across the cell cytoplasm. Also of importance is the finding of the tubular structure in both the endothelial cell and the pericyte, a point which further links these cells to each other.

SUMMARY

A tubular structure is described as occurring in large numbers in both the endothelial cells and pericytes of normal human capillaries. It is similar to that "body" found in the endothelial cells of small arteries in the lung of man and rat as well as in the skin vessels of the *Ambylstoma.* The morphologic characteristics of this structure are outlined.

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