ULTRASTRUCTURAL STUDIES ON
THE LYMPHATIC ANCHORING FILAMENTS

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ABSTRACT

The fine structure of the lymphatic capillary and the surrounding tissue areas was investigated. Instead of a continuous basal lamina (basement membrane) surrounding the capillary wall, these observations revealed the occurrence of numerous fine filaments that insert on the outer leaflet of the trilaminar unit membrane of the lymphatic endothelium. These filaments appear as individual units, or they are aggregated into bundles that are disposed parallel to the long axis of the lymphatic capillary wall and extend for long distances into the adjoining connective tissue area among the collagen fibers and connective tissue cells. The filaments measure about 100 Å in width and have a hollow profile. They exhibit an irregular beaded pattern along their long axis and are densely stained with uranyl and lead. These filaments are similar to the microfibrils of the extracellular space and the filaments observed in the peripheral mantle of the elastic fibers. Infrequently, connections between these various elements are observed, suggesting that the lymphatic anchoring filaments may also contribute to the filamentous units of the extracellular space. It is suggested that these lymphatic anchoring filaments connect the small lymphatics to the surrounding tissues and represent the binding mechanism that is responsible for maintaining the firm attachment of the lymphatic capillary wall to the adjoining collagen fibers and cells of the connective tissue area.

INTRODUCTION

In an earlier light microscopic investigation on the structure and function of the lymphatics, Pullinger and Florey (1935) observed that the lymphatic capillaries were in intimate association with the surrounding tissue by fine strands of reticular fibers and collagen. These investigators suggested that the connection of the collagen and reticulum to the lymphatics was responsible for the dilatation that is seen in edematous tissue. In later studies on the ultrastructure of the normal lymphatic capillaries, Casley-Smith and Florey (1961) described bundles of collagen fibers investing the lymphatic capillaries. However, the extensive and intimate connection of the surrounding connective tissue fibers to the lymphatic endothelial surface, as suggested in the earlier studies of Pullinger and Florey (1935), was not demonstrated. During the course of our studies on the lymphatic capillaries, we have observed, in close association with the lymphatic endothelial cells, numerous fine filaments that extend into the surrounding connective tissue area. The present communication presents information on the structure of these filaments, their distribution along the lymphatic capillary wall and within the adjoining connective tissue area among the collagenous fibers and connective tissue cells.

MATERIALS AND METHODS

Ears of mice and guinea pigs were the principal tissues used in this study, but limited observations were carried out on the lymphatics of the diaphragm.
and small intestine. Pieces of tissue obtained from animals anesthetized with pentobarbital sodium or ether were placed in chilled, buffered formalin (Pease, 1962) for 2 hr and postfixed in phosphate-buffered OsO₄ (Millonig, 1961) for 1–2 hr. In some cases, the postfixation process was allowed to continue for up to 12 hr at 0°C. Other tissues were prefixed in 6.5% glutaraldehyde in phosphate buffer with 2% acrolein (pH 7.2), washed, and postfixed in phosphate-buffered OsO₄, or the tissues were fixed for 2–4 hr at 0°C in a 1% OsO₄ in Veronal-acetate or in phosphate buffer at pH 7.2. Some tissues were fixed in 2% collidine-buffered OsO₄ (Bennett and Luft, 1959) for 2–4 hr with 0.1% ruthenium red according to the recommendations of Luft (1965). We stained some of the specimens in block before dehydration with 0.5% uranyl acetate, as suggested by Farquhar and Palade (1965), to enhance contrast in the membranous structures. Some tissues were stained in 1% potassium phosphotungstate (Farquhar and Palade, 1965). We stained other tissues in the block with phosphotungstic acid (Luft, 1961) during dehydration, to enhance contrast of the fibrillar and filamentous structures. After dehydration, the tissue blocks were embedded in Epon (Luft, 1961). Sections were cut with DuPont diamond knives and stained in 5% uranyl acetate (Watson, 1958), or in lead citrate (Venable and Coggeshall, 1965). Other sections were stained in 1% aqueous phosphotungstic acid. Micrographs were obtained using a Philips EM 200 electron microscope.

**Microdensitometer tracings** were obtained with a Joyce-Loebl microdensitometer. Tracings were made at an optical magnification of 40, recorded at a medium speed, and a sensitivity of 10 with a wedge density of 1.6 D.

**OBSERVATIONS**

The observations presented here are based primarily on the studies of lymphatics from guinea pig ears and are limited to studies on the numerous fine filaments that are intimately associated with the abluminal surface of the lymphatic capillary endothelium.

1 The term “lymphatic anchoring filaments” will be used in reference to the 100-A filaments that are attached to the lymphatic wall, extend between the collagen bundles of the adjoining tissue, and seem to bind the lymphatic vessel wall to the surrounding connective tissue.

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**General Abbreviations Used in Figures**

- **af**: lymphatic anchoring filaments
- **bl**: basal lamina
- **c**: injected carbon particles
- **ce**: centriole
- **CF**: collagen fibers
- **cf**: cytoplasmic filaments
- **CT**: connective tissue area
- **cr**: coated vesicles
- **dea**: dense cytoplasmic accumulation
- **dm**: dense material in vesicles
- **E**: lymphatic endothelium
- **ef**: elastic fiber
- **ep**: endothelial projection
- **er**: endoplasmic reticulum
- **G**: Golgi Apparatus
- **gv**: Golgi vesicles
- **j**: cell junction
- **L**: lumen
- **m**: mitochondrion
- **md**: microtubule
- **n**: nucleus
- **r**: ribosomes
- **s**: pinocytotic vesicles

**FIGURE 1** Oblique section through lymphatic capillary which demonstrates an interdigitating cell junction (j). A filamentous network (af) separates the lymphatic endothelium from the surrounding connective tissue area (CT). The endothelial cell contains the usual complement of organelles. A well developed Golgi apparatus (G) with its cisternae and numerous vesicles (gv) is shown. Mitochondria (m), ribosomes (r), a sparse endoplasmic reticulum (er) of the rough variety, and part of a centriole (ce) occur at periphery of the Golgi apparatus. The very small dots represent cross-sections of the cytoplasmic filaments (cf). Endothelial processes (ep) extend into lumen (L) of capillary. Pinocytotic vesicles (s) also occur throughout the cytoplasm. Specimen fixed in 1% OsO₄ in phosphate buffer (pH 7.2). Blocks treated with uranyl acetate in Michaelis buffer (pH 5), and sections were doubly stained in uranyl acetate and lead citrate. Other sections were stained in 1% aqueous phosphotungstic acid. Micrographs were obtained using a Philips EM 200 electron microscope.

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Figure 2  Cross-section through lymphatic capillary illustrating the relation of vessel to the surrounding connective tissue areas (CT; arrows). Note the variations in width of endothelial wall (double arrows). Four cell junctions (j) are observed at various points around the capillary wall. Except for a very short area of basal lamina (bl), the vessel is surrounded by numerous anchoring filaments (af). Specimen prefixed in 6.5% glutaraldehyde with 2% acrolein in phosphate buffer (pH 7.2), followed by 1% OsO₄ in phosphate buffer. Sections double stained with uranyl and lead stains. × 16,000.

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FIGURE 3. Section through the lymphatic endothelium to illustrate its width at the region of the nucleus (n). A well developed Golgi apparatus (G) consisting of piles of flattened cisternae and vesicles (gv), numerous cytoplasmic filaments (cf), and mitochondria (m) occur in the cytoplasm. Free ribosomes (r), scant endoplasmic reticulum (er), and many pinocytotic vesicles (v) also occur throughout the cytoplasm. An abundant supply of anchoring filaments (af) occurs along the abluminal surface of lymphatic endothelium. Short, irregular patches of basal lamina (bl) are also shown. Specimen fixed in 1% OsO₄ in phosphate buffer (pH 7.4). Tissue blocks stained in aqueous 1% potassium phosphotungstate. Sections double stained with uranyl and lead. × 23,000.
General Cytology of the Lymphatic Capillary

In our earlier studies of the lymphatic capillaries (Leak and Burke, 1966), several features were identified which may serve as criteria for differentiating these vessels from the blood capillary: i.e., the lymphatic capillary can be distinguished by (1) its wider lumen, (2) a discontinuous basal lamina along the outer endothelial surface, (3) open intercellular junctions, and (4) the presence of numerous fine filaments along the abluminal endothelial surface. The lymphatic endothelial cells overlap, or interdigitate at their margins, and are held in close apposition, without being folded over each other, to form cell junctions that may be partially or completely open. In cross- and longitudinal sections, the lymphatic capillaries are very irregular in outline, and the endothelial wall measures from 0.1 to several micra in thickness in sections that pass through the nucleus or through the juxtanuclear area in which the cytoplasmic organelles are concentrated (Figs. 1–3).

The endothelial cells of the lymphatic capillary possess the usual compliment of organelles (Figs. 1, 2), in addition to a system of fine cytoplasmic filaments that measure 60–80 Å in diameter and are of an indefinite length. In many areas of the cytoplasm, the filaments are quite numerous and may be tightly packed in bundles or fascicles that course along the periphery of the cell (Figs. 4 and 5). Frequently, the plasmalemma on the abluminal surface is reinforced by accumulations of dense material in the subjacent cytoplasm, as shown in Fig. 4.

Disposition of Lymphatic Anchoring Filaments

The relation of the lymphatic capillary to the adjoining connective tissue is demonstrated in Fig. 2. The continuous basal lamina that is characteristic of the blood capillary is not present. Instead, the continuity of this dense band (250–700 Å in width) is interrupted by numerous fine filaments that form an irregular network between the abluminal endothelial surface of the lymphatic capillary and the adjoining connective tissue (Figs. 1–3). Frequently, the filaments are aggregated into bundles that are disposed parallel to the long axis of the lymphatic capillary wall and continue for long distances into the adjoining connective tissue area among the collagen bundles and connective tissue cells (Figs. 4–6, 9).

Ruthenium red, when used in combination with collidine-buffered osmium tetroxide, also provides information on the intimate association of anchoring filaments to the lymphatic wall. Increased clarity is observed in these specimens as a result of the dye’s binding to the outer leaflet of the cell unit membrane or reacting with substances rich in mucopolysaccharides that reside on the external surface of the cell membrane (Luft, 1964). In such preparations, the anchoring filaments appear to be inserted on the outer leaflet of the trilaminar unit membrane to terminate within the dense-staining substance on the external surface of the unit membrane (Figs. 7, 8). The apparent insertion of anchoring filaments on the outer leaflet of the trilaminar unit membrane is also observed in preparations which lack ruthenium red stain (Figs. 4, 10, 12, 13, 20). Occasionally, they are inserted in localized areas of increased electron opacity that occur along the outer surface of the lymphatic endothelium (Fig. 14). Some of these dense areas resemble the hemidesmosomes of the basal epithelial layer of the epidermis. Other areas of the dense regions seem to represent extracellular accumulations of dense material that is very similar to that comprising the basal lamina of blood capillaries.

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**Figure 4** This longitudinal section through part of a lymphatic capillary demonstrates the anchoring filaments (af) that course along the lymphatic wall. Note the beading pattern throughout the long axis of the anchoring filaments (double arrows). Some of the filaments insert on the outer leaflet of the trilaminar unit membrane of the lymphatic endothelium (single arrows). Endothelial projections (ep) with closely associated filaments (af) extend into the adjoining connective tissue area (CT). Note dense cytoplasmic accumulation (dea) at periphery of endothelium. Pinocytotic vesicles (v) occur along both abluminal and luminal surfaces of endothelium. Numerous free ribosomes (r), in addition to microtubules (mt), cytoplasmic filaments (cf), and mitochondria (m), occur in the cytoplasm. Coated vesicles (cv) are also shown. Part of nucleus (n) is located in lower portion of cell. Specimen fixed and stained as in Fig. 2. X 45,000.
FIGURES 5 and 6  Portion of lymphatic endothelial cell which demonstrates the intimate association of the anchoring filaments (af) with the abluminal surface and the extension of these filaments among collagen fibers (CF) of the adjoining connective tissue (CT). The areas between the arrows represent grazing sections of endothelial plasmalemma and illustrate the intimate association of the anchoring filaments to the latter. Numerous cytoplasmic filaments (cf) and pinocytotic vesicles (v) are observed throughout the cytoplasm. A small segment of basal lamina (bl) is also shown. Specimen fixed and stained as in Fig. 2. Fig. 5, × 31,000. Fig. 6, × 69,000.
Figures 7 and 8. Sections of lymphatic capillary from tissue fixed in collidine-buffered OsO$_4$ with the dye ruthenium red. The image of cell membranes is enhanced, owing to binding of the dye to substances in or on the outer leaflet. The insertion of anchoring filaments (af) on the outer leaflet of cell membrane is illustrated at arrows. Sections double stained with uranyl and lead stains. Collagen fibers (CF) and lymphatic lumen (L) are as marked. Fig. 7, × 43,000. Fig. 8, × 48,000.
Anchoring filaments (af) emanate from the lymphatic endothelial processes (ep) and continue for varying distances among the collagen bundles (CF). Specimen prefixed in 6.5% glutaraldehyde with 2% acrolein and 0.1% ruthenium red in phosphate buffer (pH 7.2), followed by postfixation in 1% OsO₄ in phosphate buffer (pH 7.2). Section stained in lead. X 5,000.

The insertion of anchoring filaments is also apparent at surfaces of the endothelial projections that are observed along the outer aspect of the lymphatic capillary wall (Figs. 4, 9, 10, 15, 16). The margins of the lymphatic endothelia (cell junctions) which lie adjacent to the connective tissue area also contain filaments that extend deep into the adjoining tissue areas. This is observed in open cell junctions (patent junctions) in addition to the cell margins that are closely apposed to each other. This situation is encountered with some regularity in the normal tissue (Figs. 17, 18) and is also maintained during the inflammatory state (Leak and Burke, 1965).

**Fine Structure of Lymphatic Anchoring Filaments**

The anchoring filaments observed in this study vary in diameter from 40 to 110 Å. The smaller ones (40–60 Å in diameter) are embedded in irregular dense patches of the discontinuous basal lamina (Fig. 14) and also intermingle with the large filaments to form loose skeins between the lymphatic endothelial cell and surrounding tissue (Fig. 1, 3). The larger filaments are inhomogeneous in structure and measure from 100 to 110 Å in diameter. Their length is undefined; however, in appropriate sections, lengths up to 10 µ have been measured (Figs. 4, 9, 10). In cross-sections, the lymphatic anchoring filaments have a light core surrounded by a dense outer layer, suggesting that these filaments either have a tubular structure or have a cortex and medulla with different affinities for osmium tetroxide and/or the uranyl and lead stains used in preparation of the tissues (Fig. 22). In sections which demonstrate the longitudinal appearance of these filaments, two parallel strata of medium density are separated by a central light interval (Fig. 20). When observed as long strands, the anchor-
FIGURE 10 Cytoplasmic bleb (ep) represents a portion of endothelial cell projection which is surrounded by the anchoring filaments (af) that extend from the main part of lymphatic wall. Some of the filaments exhibit a beaded pattern (arrows) along their long axis. This grazing section across endothelial surface illustrates the insertion of anchoring filaments on the outer leaflet of the unit membrane, or within the surface layer which resides exterior to the outer leaflet of the trilaminar unit membrane. Ribosomes (r) and pinocytotic vesicles (v) are observed in cytoplasm. Fixation and staining as in Fig. 2. X 51,000.

FIGURE 11 Enlarged magnification of anchoring filaments from Fig. 10 which demonstrates the beaded pattern that is present in these filaments (arrows). X 238,000.

Filaments exhibit a beaded pattern along their long axis (Figs. 4, 9, 10, 11). The periodicity of the beaded pattern measures 100-110 Å, which is also very close to the width of the filaments.

Microdensitometer tracings of both longitudinal and cross-sectional views of the anchoring filaments show two high density peaks that are separated by a very low gap (Figs. 21, 23), which also suggest a tubular or hollow structure for these filaments. The microdensitometer tracings across the width of longitudinal filaments give an outside diameter of 95 Å, while tracings across the transverse sections of these filaments measure 100 Å. These measurements fall reasonably close to the average measurements made by visual methods (100-110 Å).
FIGURE 12. The insertion of individual anchoring filaments (gf) to the outer leaflet of the unit membrane of lymphatic endothelium is illustrated at several regions (arrows) in this micrograph. Fixative and staining as in Fig. 1. X 51,000.

Staining Characteristics of Filaments

When sections are stained in uranyl acetate and lead, the anchoring filaments are stained more intensely than the collagen fibers (Fig. 18). However, when sections are stained with aqueous PTA, the reverse situation is observed, as shown in Fig. 19.

Infrequently, individual collagen fibrils are observed in close association with the plasma-lemma of the lymphatic endothelium, but, for the most part, they are separated from the latter by the anchoring filaments. Elastic fibers are also observed in close proximity to the lymphatic capillary wall. The filaments that surround the elastic fibers are very similar in structure and staining properties to the lymphatic anchoring filaments, and frequently the anchoring filaments appear to be continuous with the peripheral filaments of the elastic fibers (Figs. 18, 24). The central core of the elastic fibers and the individual collagen fibers are more intensely stained with PTA than the filaments that comprise the mantle of the elastic fibers or the lymphatic anchoring filaments (cf. Figs. 19 and 24). The frequent images of the anchoring filaments that continue around the periphery of the elastic fibers also suggest that the lymphatic anchoring filaments may possibly contribute to the mantle of peripheral filaments that comprise the elastic fiber.

DISCUSSION

Our observations of the lymphatic capillaries provide morphological information not previously available: i.e., the ultrastructural demonstration of filaments along the lymphatic capillary wall that insert on the outer leaflet of the unit membrane of lymphatic endothelial cells and extend for varying distances into the adjoining connec-
FIGURE 13 A pinocytotic vesicle which contains a filament (arrow) is demonstrated. A coated vesicle (cv) occurs at left of micrograph. Cell junction (j) is at right. Fixed and stained as in Fig. 1. × 31,000.

The relationship of the lymphatic capillary to the surrounding tissue is summarized in the diagram in Fig. 25. The regular occurrence of the lymphatic anchoring filaments provides morphological data which strongly suggest that these structures represent the binding mechanism that is responsible for maintaining the firm attachment of the lymphatic capillary wall to the surrounding collagen fibers and cells of the connective tissue areas. Our evidence confirms the earlier supposition made by Drinker and Field (1933), who suggested, “A further possibility for which no proof exists, is that the delicate lymph capillaries are fixed to surrounding tissues by fine strands of reticulum, and that muscular movements by pulling on these strands may induce distortion and temporary openings, through which fluid enters eventually to reach a valved trunk from which escape does not occur.”

The demonstration of numerous lymphatic anchoring filaments can be correlated with the earlier observation by light microscopy which describes fibers investing the dilated lymphatic capillaries during the inflammatory state (Pullinger and Florey, 1935). Instead of collagen fibers being directly attached to the lymphatic endothelial wall, as indicated by the earlier work (Pullinger and Florey, 1935), the present observations demonstrate that numerous fine filaments either insert on the outer leaflet of the trilaminar unit membrane or are embedded in an electron-opaque material associated with the external surface of the endothelial cell membrane. The increased density observed in membranes from preparations treated with ruthenium red stain suggests the presence of mucopolysaccharide on the external surface of the lymphatic endothelial membrane. Such a layer may possibly serve as a matrix in which the filaments insert or become firmly attached. The recent studies of Luft (1964, L. V. Leak and J. F. Burke  Lymphatic Anchoring Filaments  141
Accumulations of dense material occur along endothelial surface (arrows). The anchoring filaments (af) are also inserted in areas of increased electron opacity. These dense areas resemble the hemidesmosomes observed in the basal epithelial layer of the epidermis. Irregular strips of basal lamina (bl) are also observed. Part of cell junction (j) occurs at left of micrograph. The cytoplasm contains numerous vesicles some of which contain an electron-opaque material (dm). Coated vesicles (cv), mitochondria (m), free ribosomes (r), and cytoplasmic filaments (cf) are observed in the cytoplasm. Fixed and stained as in Fig. 1. X 32,000.

1965) demonstrated the occurrence of mucopolysaccharide materials on the luminal surface of blood vessels and the surfaces of a number of different cell types. It is suggested that the anchoring filaments provide a firm connection between the lymphatic wall and surrounding tissue, so that pressure changes occurring in the tissue spaces would produce tension on the collagen bundles in which these anchoring filaments are embedded. One can speculate that, during the inflammatory state, as the collagen and elastic fibers are moved apart by increase in interstitial fluid, the walls of the lymphatic capillary are pulled upon by the anchoring filaments and collagen bundles, thereby causing a widening of its lumen. On the basis of our findings, it may be assumed that the normal accumulations of connective tissue fluid would also produce similar changes tending to keep the lymphatics open, but to a lesser degree than during the inflammatory state.

The intimate relation of the anchoring filaments to the lymphatic endothelium suggests the possibility that the precursors for these filaments as well as the discontinuous basal lamina (basement membrane) may be synthesized by the lymphatic endothelial cells. However, radioautographic evidence is needed to substantiate this supposition. Filaments of a similar nature have been described in close relation to the inner layers of the basement membrane in the glomerular capillary wall (Farquhar et al., 1961), the outer layers of the basement membrane of muscle capillaries (Palade and Bruns, 1964), and various epithelia (Low, 1961, 1962). Filaments of similar morphology also occur in large numbers throughout the connective tissue areas (Low, 1962) and
are regularly encountered in the mantle that is observed at the periphery of the elastic fibers (Karrer, 1958, 1960a, 1960b; Banfield and Brindley, 1963; Palade, 1961; Low, 1962; Greenlee et al., 1966; Taylor and Yeager, 1966, and Fahrenbach et al., 1966). It is of further interest to note that the anchoring filaments as well as microfibrils of the extracellular space and the peripheral fibrils of elastic fibers give a similar morphological picture when stained with uranyl acetate and lead, and that all three filamentous elements are faintly stained with PTA.

Although higher resolution micrographs of both cross- and longitudinal sections of the individual filaments demonstrate a hollow profile, a beaded pattern suggests that an irregular periodicity (110 Å) is present in the anchoring filaments (cf. Figs. 9-11 with 20). Similar beaded patterns were reported by Karrer (1960a, 1961), Haust (1965), and Fahrenbach et al. (1966), for the fibrils of the elastic fibers and by Palade and Bruns (1964) for filaments bordering the basement membrane of muscle capillaries. From her observations of microfibrils of the extracellular space, Haust (1965) suggested that the periodicity (70-140 Å) is established by chainlike aggregations of very small round-to-oval vesicles that may be closely aligned or partially overlapping each other. Fahrenbach et al. (1966) suggested that the filaments of developing elastin consist of cylindrical or subspherical units that are 130 Å long and of an equal diameter, and that these units are separated by 50-Å-long electron-opaque sections. These investigators also observed a similar pattern in negatively stained preparations of the same tissue; however, the over-all dimen-
FIGURE 16 Endothelial projection (ep) with anchoring filament (af) that extends toward the adjacent connective tissue area (CT). Fixed and stained as in Fig. 1. \( \times 42,500. \)

FIGURE 17 Part of the terminal cell process which comprises the cell junction (j) contains anchoring filaments (af) that extend into the connective tissue area (arrow). Specimen fixed in 1% OsO\(_4\) in s-collidine buffer (pH 7.2) with 0.1% ruthenium red. Section doubly stained with uranyl and lead. \( \times 31,500. \)

sections were much larger, perhaps because of swelling due to the methods of preparations.

Our results suggest, therefore, that the lymphatic anchoring filaments serve to bind or connect the lymphatic capillary wall to the adjoining connective tissue. In addition, they are in close topographical association with the microfibrils of the extracellular space and the peripheral fibrils of the elastic fibers. All three of these filamentous elements also possess similar structural and staining properties, suggesting that they may be identical.

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FIGURE 18  The anchoring filaments (af) illustrated in this micrograph lie in close proximity to the adjacent elastic fiber (ef). Several anchoring filaments (af) appear to be continuous with the peripheral filaments of the elastic fiber (arrow). Specimen fixed as in Fig. 4 and double stained with uranyl and lead. × 51,000.

FIGURE 19  The central area of the elastic fibers (ef) and collagen fibers (CF) are densely stained with phosphotungstic acid. However, the anchoring filament and fibrils around the elastic fibers (arrows) are not so densely stained with PTA as in sections that are doubly stained with uranyl and lead. Specimen fixed in 1% OsO4 in phosphate buffer (pH 7.2). Tissue stained in block with uranyl acetate. Section stained with 1% aqueous PTA. × 30,000.
FIGURES 20 and 21 Portion of lymphatic endothelium (E) which illustrates the insertion of anchoring filament (af) on outer leaflet of the trilaminar unit membrane. × 170,000. Microdensitometer tracing across anchoring filament near arrow is shown in Fig. 21. Lever ratio 100:1; slit width 0.5 mm. × 700,000.

FIGURES 22 and 23 Cross-sections of two anchoring filaments which illustrate a light central core that is surrounded by a dense circumferential layer. × 407,000. Fig. 23 shows a microdensitometer tracing across one of the filaments at arrow. Lever ratio 100:1; slit width 0.1 mm. × 800,000.
Figure 24  Part of lymphatic endothelium which demonstrates the relation of elastic fiber (ef) to lymphatic vessel as observed in longitudinal sections. Several anchoring filaments (af) are continuous with peripheral filaments of the elastic fiber (arrows). An extensive Golgi apparatus (G), mitochondria (m), free ribosomes (r), and part of the nucleus (n) are observed. Pinocytotic vesicles (v) occur along both luminal and abluminal regions of cell. Dense membranes (*) are thought to represent artifacts, probably as a result of fixation. Specimen fixed in 6.5% glutaraldehyde with 2% acrolein, followed by 1% OsO₄ in phosphate buffer (pH 7.2). Double stained with uranyl and lead. X 51,000.
A three-dimensional, interpretative diagram of lymphatic capillary that was reconstructed from collated electron micrographs. The three-dimensional relation of the lymphatic capillary to the surrounding connective tissue area is illustrated. The lymphatic anchoring filaments appear to originate from the endothelial cells, and extend among collagen bundles, elastic fibers, and cells of the adjoining tissue area, thus providing a firm connection between the lymphatic capillary wall and the surrounding connective tissue. Irregular basal lamina and collagen fibers are as marked.
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