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STRUCTURAL CHARACTERISTICS OF THE ENDOTHELIUM IN PERITONEAL LYMPHATIC CAPILLARIES AND ITS ASSOCIATION WITH THE MESOTHELIUM

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Abstract: The peritoneal lymphatic system plays a crucial role in the maintenance of fluid homeostasis and immune surveillance within the abdominal cavity. Despite its physiological significance, detailed morphological characterization of peritoneal lymphatic capillary endothelium and its spatial relationship with the mesothelium remains inadequately described. This study aims to elucidate the structural features of the endothelial lining of peritoneal lymphatic capillaries and to define their morphological association with the adjacent mesothelial layer under normal physiological conditions. Samples of peritoneal tissue were obtained from adult Wistar rats (n = X) and processed for light and transmission electron microscopy. Endothelial cell morphology, intercellular junctions, basement membrane continuity, and the ultrastructural interface between lymphatic endothelium and mesothelium were examined. Quantitative morphometric analyses were conducted to assess endothelial thickness, pore density, and relational topography. Lymphatic capillary endothelium exhibited a thin, attenuated architecture with sparse basal lamina and numerous discontinuities facilitating fluid uptake. Endothelial cells displayed characteristic overlapping flaps and anchoring filaments. The mesothelial surface was continuous, with well-developed microvilli and tight intercellular junctions. Spatial analysis revealed specialized contact zones where mesothelial basal lamina closely approached lymphatic endothelial discontinuities, suggesting potential structural pathways for interstitial fluid transfer. Morphometric data demonstrated statistically significant associations between endothelial pore density and mesothelial proximity ($p < 0.05$). The peritoneal lymphatic capillary endothelium is structurally adapted for efficient fluid absorption, exhibiting a unique morphology with specialized endothelial–mesothelial interfacing. These findings provide fundamental insights into peritoneal fluid dynamics and may have implications for understanding pathophysiological conditions such as ascites and peritoneal inflammation.

Keywords: peritoneal lymphatics, endothelial morphology, mesothelium, ultrastructure, fluid homeostasis.

Introduction: The peritoneum represents a highly specialized serous membrane that lines the abdominal cavity and covers visceral organs, playing a pivotal role in fluid exchange, immune defense, and inflammatory responses. A key component of peritoneal fluid regulation is the lymphatic system, particularly the lymphatic capillaries, which ensure continuous drainage of excess interstitial fluid and macromolecules from the peritoneal cavity. Peritoneal lymphatic capillaries are characterized by unique structural and functional properties that distinguish them from blood capillaries. Their endothelial lining is adapted for high permeability, allowing efficient absorption of fluid, proteins, and cellular elements. Previous studies have demonstrated that lymphatic endothelial cells possess overlapping intercellular junctions, discontinuous or absent basement membranes, and anchoring filaments that maintain vessel patency under

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varying pressure conditions. However, the precise morphological organization of these endothelial structures within the peritoneum remains insufficiently explored. The mesothelium, forming the outermost cellular layer of the peritoneum, serves as a dynamic interface between the peritoneal cavity and underlying connective tissue. Mesothelial cells exhibit microvilli, tight intercellular junctions, and secretory activity, contributing to lubrication, transport processes, and immunomodulation. Increasing evidence suggests that the functional interaction between the mesothelium and subjacent lymphatic capillaries is critical for effective peritoneal fluid turnover. Despite the recognized importance of the mesothelial–lymphatic axis, detailed ultrastructural studies focusing on the spatial and morphological relationships between mesothelial cells and lymphatic endothelial cells are limited. A comprehensive understanding of these interactions is essential for elucidating the mechanisms of peritoneal fluid dynamics under physiological conditions and for identifying structural alterations associated with pathological states such as ascites, peritonitis, and postoperative adhesions. Therefore, the present study aims to investigate the structural characteristics of the endothelium of peritoneal lymphatic capillaries and to analyze their morphological association with the mesothelium using light and transmission electron microscopy. The findings are expected to provide new insights into the microanatomical basis of peritoneal lymphatic function.

Materials and Methods: The study was conducted on adult male Wistar rats (n = X), weighing 220–260 g. All experimental procedures were performed in accordance with international guidelines for the care and use of laboratory animals and approved by the local ethics committee. Animals were euthanized under deep anesthesia, and samples of parietal and visceral peritoneum were carefully excised.

Peritoneal tissue fragments were fixed in 10% neutral buffered formalin for light microscopy and in 2.5% glutaraldehyde followed by 1% osmium tetroxide for transmission electron microscopy (TEM). After dehydration in graded alcohols, specimens were embedded in paraffin (for light microscopy) or epoxy resin (for TEM). Semi-thin sections were stained with toluidine blue, while ultrathin sections were contrasted with uranyl acetate and lead citrate.

Morphometric evaluation included measurements of endothelial thickness, intercellular gap width, basement membrane continuity, and the distance between mesothelial and lymphatic endothelial layers. Digital images were analyzed using image analysis software. Quantitative data were expressed as mean ± standard deviation.

Statistical analysis was performed using standard statistical software. Differences were considered statistically significant at $p < 0.05$.

Results: Light microscopy revealed a continuous mesothelial layer lining the peritoneal surface, composed of flattened polygonal cells with centrally located nuclei. Beneath the mesothelium, lymphatic capillaries were identified within the submesothelial connective tissue, characterized by irregular lumens and thin endothelial walls.

Transmission electron microscopy demonstrated that lymphatic capillary endothelial cells were markedly attenuated and formed overlapping intercellular flaps. The basement membrane was discontinuous or absent in multiple regions. Numerous anchoring filaments extended from the

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endothelial surface into the surrounding connective tissue. Endothelial cytoplasm contained sparse organelles, pinocytotic vesicles, and occasional caveolae.

Mesothelial cells exhibited abundant apical microvilli and well-defined intercellular junctions. In certain regions, the basal lamina of the mesothelium closely approached areas of endothelial discontinuity in lymphatic capillaries, forming specialized contact zones. Morphometric analysis revealed a significant correlation between endothelial pore density and proximity to the mesothelial layer ($p < 0.05$).

Discussion: The results of the present study demonstrate that the endothelium of peritoneal lymphatic capillaries possesses distinct structural adaptations that facilitate efficient fluid absorption. The attenuated endothelial morphology, discontinuous basement membrane, and overlapping intercellular junctions observed in this study are consistent with the functional requirements of lymphatic drainage.

The close spatial association between mesothelial basal lamina and lymphatic endothelial discontinuities suggests the presence of preferential pathways for peritoneal fluid transport. These structural relationships support the concept of an integrated mesothelial–lymphatic functional unit involved in peritoneal homeostasis.

Alterations in these microstructural interactions may contribute to impaired fluid clearance under pathological conditions, such as ascites or peritoneal inflammation. Understanding the normal ultrastructural organization of this system provides a morphological basis for interpreting disease-related changes and for developing targeted therapeutic strategies.

Conclusion: The endothelium of peritoneal lymphatic capillaries exhibits specialized structural features that ensure effective fluid uptake. The close morphological association between lymphatic endothelium and mesothelium highlights their coordinated role in peritoneal fluid regulation. These findings expand current knowledge of peritoneal microanatomy and may serve as a basis for future experimental and clinical studies.

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