ULTRASTRUCTURAL CHARACTERISTICS OF TERMINAL BLOOD VESSELS IN THE MUCOUS TUNIC OF COLON IN RAT

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Terminal vessels in colon mucous tunic form a network with two capillary regions: subepithelial and periglandular region (1, 2) with different functional importance. In this sense the ultrastructure of their walls is of essential interest because on its basis one can ascertain to the greatest extent their fine functional relationships and first — the specific mechanisms of transendothelial transport in them. However, there are no concrete data available in this respect. The concept which is generally accepted considers capillaries in intestinal mucous tunic to be of fenestrated type, i. e. mainly those in the intestine but not in the colon are concerned (3—6, 9—12, 15). In other investigations (7) the data about colon capillaries are restricted to their permeability. That is why they cannot serve adequately as an ultramorphological basis for clarifying the functional peculiarities of this microcirculatory region.

Material and methods

The study covered material taken from the ascending and descending colon of 6 adult male rats. Prior to material taking an intravital fixation with 5 per cent solution of glutaraldehyde for 10 min was done by means of introduction of the fixator into the colonic lumen and making wet their outer surface. A prefixation was performed with 5 per cent solution of glutaraldehyde in 0,1 mol cacodilate buffer with pH 7,4 for 2 hours followed by postfixation with 2 per cent osmium tetraoxide for 2 hours at 4 °C. After dehydratation material was embedded in Durcupan. Ultrathin sections were double contrasted with uranyl acetate and lead citrate. Observations were made on the electron microscope JEM-7A.

Results and discussion

The ultrastructure of the wall of terminal vessels in colon mucous tunic showed definite differences in dependence on their localization. We divided them into two groups, namely periglandular and subepithelial having in mind Marinov's et al. (2) description. Terminal vessels of the first group located around the glandular fundus and corpus consist most often of non-fenestrated capillaries with lumen size of 4—5 mkm. In cross-section their wall is formed by one or two endothelial cells which are extranuclearly about 300—800 nm thick. Dark and light endothelial cells occur, too. The latter ones prevail (fig. 1).

It is notable that there is a large amount of micropinocytotic vesicles which are predominantly bound to the luminal and abluminal surfaces in the nucleus-containing zone. Most of them are free when paranuclear and thickened areas of peripheral zone are concerned. We observe rather often a fusion of two or even

more vesicles thus forming vacuoles and transendothelial channels. In the thickened areas of the peripheral zone we establish coated pits and vesicles. In the same zone we ascertained the presence of microtubules and microfilaments (fig. 1), single cisternae of smooth endoplasmic reticulum, single lysosomes and multi-

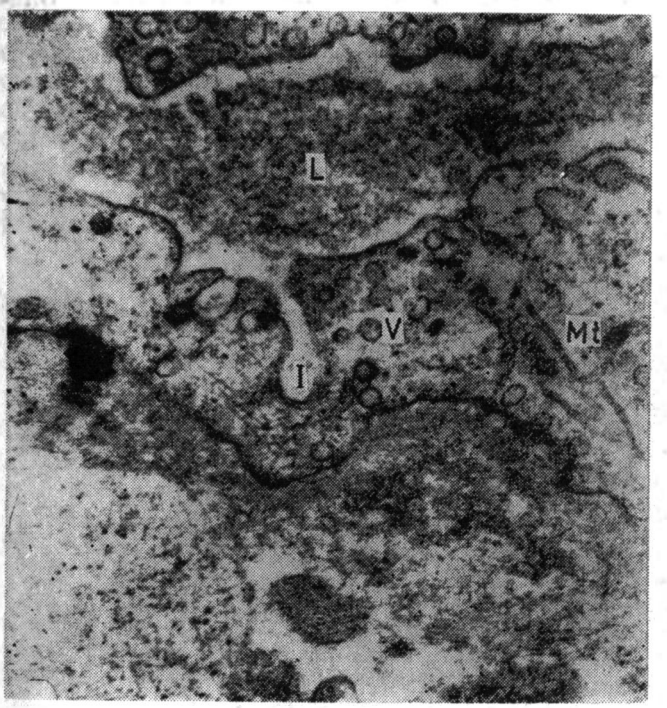

Fig. 1. Part of non-fenestrated capillary. L — lumen, I — invagination, V — pinocytotic vesicle MT — microtubules. Magn.×20 000

vesicular bodies, and rarely Weibel-Palade bodies. Only single periglandular vessels possess endothelial cells with thickness to the side of the glandular cells to be considerably less (50—100 nm). In such regions the presence of single fenestrae can also be established.

Endothelial cell surface possesses numerous evaginations and invaginations mainly on the luminal surface. Peripherically, they are considerably more and vary in form, length and thickness. In the zone of interendothelial contact there are terminal evaginations with apical enlargements (fig. 2). There is a wealth of form and size when invaginations of luminal cytolemma are concerned. Some of them are connected with the lumen by means of an aperture of different size that is often rather tight but other ones are completely closed luminally on a given section (fig. 1). In our opinion, they present longitudinal grooves and channels in the depth of the endothelial cells. The wall of certain larger invaginations thickens to such an extent that single fenestrae can be seen.

The interendothelial contact structure shows a variety in dependence on the thickness of contact surfaces. In thickened areas well-expressed interdigitations are observed while in the thin ones the interendothelial fissure is most often obli-

quely oriented. Along it specialized contacts can be established — near the lumen they are most frequently of occlusive type but towards the basal membrane one to several desmosomes are located (fig. 2).

Basal membrane is always well-deligned and its electron dense part is between 60 and 80 nm. It also envelopes single pericytes which never form an inte-

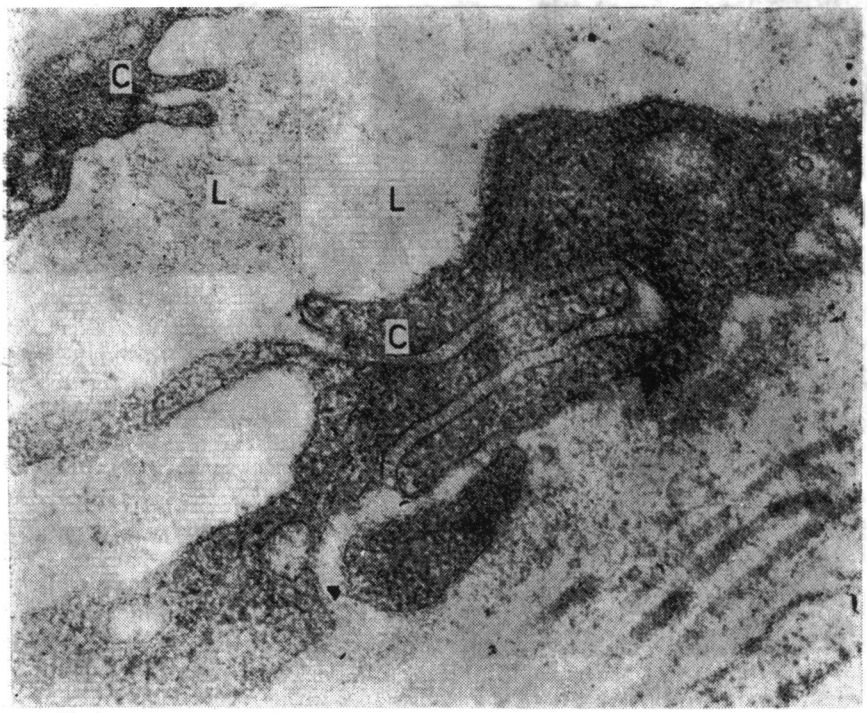

Fig. 2. Interdigiting interendothelial contact. Lumenally — tight junction with a terminal evagination. Magn. × 50 000
Inset: Oblique interendothelial space. Lumenally — tight junction and terminal evaginations of the two neighbouring endothelial cells. Magn. × 20 000 C — contact. L — lumen

gral layer. Pericapillary space is broad about 350—700 nm. It is narrower from the side of glandular cells and contains a fine filamentous substance in a different amount. In the region of lamina propria collagen fibres and single processes of pericapillary cells prevail. In the immediate proximity of the endothelial cell we observe parts of nerve fibres and nerve endings.

Subepithelial vessels consist of broader capillaries most often of fenestrated type. Mean diameter is 7—8 mkm. Endothelial cells are thinner. Their thickness is about 200 nm at the average in the extranuclear zone. It is between 50 and 100 nm in peripheral areas where fenestrateds lamellae can be seen. The wall of present invaginations possesses almost alway fenestrae. Pericapillary space is narrower from the side of the epithelial cells and the amount of collagen fibres is smaller.

The results received demonstrate that the ultrastructure of the wall of terminal blood vessels forming of a capillary network around the glands undergoes

changes in direction from the fundus to the tip. The basic tendency is that when the calibre of the vessels increases the thickness of endothelial cells decreases, and the number of fenestrated vessels and their degree of fenestration increases. These data indicate that permeation capacities of the vessels increase in this direction on the account of transfenestral transport and that they are at the best-expressed in subepithelial vessels (5). These structural peculiarities of the subepithelial vessels can be related with their resorptive function. The large amount of micropinocytotic vesicles of periglandular vessels shows that the transport of water soluble molecules is realized mainly through vesicular transport (transcytosis) (8, 13, 14). Luminal evaginations and invaginations forming channels and grooves serve as local means increasing the permeability capacities of these vessels most probably by delay of blood flow and shortening the distance between the lumen and the pericapillary space.

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УЛЬТРАСТРУКТУРНАЯ ХАРАКТЕРИСТИКА ТЕРМИНАЛЬНЫХ КРОВЕНОСНЫХ СОСУДОВ В СЛИЗИСТОЙ ОБОЛОЧКЕ ТОЛСТОЙ КИШКИ У КРЫС

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РЕЗЮМЕ

Исследовалась ультраструктура стенки терминальных кровеносных сосудов в слизистой оболочке толстой кишки взрослых мужских крыс. Полученные данные показывают, что наряду с увеличением просвета сосудов по направлению от дна железы к ее устью, отмечаются изменения и ультраструктуры их стенки. В области дна и тела желез терминальные сосуды представляют собой нефенестрированные капилляры со сравнительно небольшим просветом, где перенос веществ осуществляется посредством везикулярного транспорта. Наряду с этим наблюдаются и локальные механизмы, которые увеличивают пермеабилитетные возможности этих сосудов. Они представлены отростками и инвагинациями цитолемы просвета, которые образуют продольные ульи и каналы в толще эндотелиальной клетки. Чем ближе к устью железы, тем тоньше и слой эндотелия сосудов. В таком направлении увеличивается количество фенестрированных сосудов и повышается степень их фенестрированности. Эти изменения говорят об увеличении пермеабилитетных возможностей сосудов, которые наиболее сильно выражены в сосудах, расположенных под эпителием.