CASE REPORT

Electron microscopic study of the arterial wall in the cerebral aneurysms

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Abstract

The ultrastructural modifications were observed in electron microscopy of the congenital aneurysm of the internal carotid artery with subarachnoid hemorrhage. The tunica intima very enlarged contains in the endothelial cells numerous microvesicles of pinocytosis, and rare cell organelles. The internal elastic lamina presented ruptured or absence zones. The luminal face of the cells appeared irregular with large evaginations and deep and narrow invaginations. Under the endothelial lining, large masses of extracellular matrix with different degrees of edema, and fragmented collagen fibrils realize a metabolic barrier between the tunica intima and media. The muscle fibers of the tunica media and the myofilaments in each myocyte are in reduced number.

***Keywords*:** electron microscopy, cerebral aneurysms, aneurysms of the internal carotid artery, subarachnoid hemorrhage.

Introduction

The cerebral aneurysms have a prevalence of 6–8% [1]. Most of the unruptured remain undiscovered, still being discovered by neuroimagistic procedures. Some of them were observed after the appearance of symptoms expressed by neurocompressions or after subarachnoidian hemorrhage after the ruptured aneurysm, the last one in proportions of 32–67% [2] having a survival of 10–20% [3].

Intracranial aneurysms are relatively common and the chance that an asymptomatic aneurysm is detected has increased with the ongoing improvement of imaging techniques.

The aneurysm of the internal carotid artery is very outstanding, referring to that the anterior, posterior or middle cerebral circulation.

Few structural and ultrastructural observations on the aneurysmal arterial wall were related [4, 5]. For this reason, our aims were:

(1) – to have new ultrastructural information in the existing data;

(2) – to increase the amount of cognitions concerning the cerebral aneurysms;

(3) – particularly to incorporate the aneurysm of congenital internal carotid artery.

Material and methods

The work has been done on congenital aneurysm of the internal carotid artery fragments, ingathered through surgical techniques by the specialized services. The fragments have been studied in electron microscope Philips with standard methodology.

Results

Internal carotid artery

Tunica intima is enlarged. The endothelial cells have an irregular luminal face, with large evaginations and deep narrow invaginations with microvilli.

The cytoplasm is loaded with numerous light microvesicles of pinocytosis. Rare dispersed cell organelles are present in the cytosol, between microvesicles (Figure 1).

The nucleus has an irregular shape with many invaginations of the nucleolemma. The nucleus appears as heterogeneous structure with electron-dense areas (heterochromatin) and with electron-lucent nuclear material (euchromatin) (Figure 2).

The microfilaments of actin and myosin are reduced in number in the cytoplasm. Under the endothelial lining, large masses of extracellular matrix containing in different degrees edema and no oriented or segmented collagen fibrils. Rare erythrocytes and macrophages are present. The internal elastic lamina show zonal interruptions, or absences here and there (Figure 3).

The tunica media is narrow, with a decreased umber of muscle cells. In the sarcoplasm, the number of myofilaments is also reduced.

The sarcolemma presents many caveolae, and frequent invaginations, determining an irregular shape of the muscle cells (Figure 4).

The tunica adventitia appears with an increased extracellular matrix, numerous connective fibers and a reduced number of vasa vasorum.

Discussions

The electrono-optic observations showed greatly alterations of the vascular wall with predominance in the tunica intima of the artery. The accumulations of large masses of connective extracellular matrix in the under endothelial lining, produce on the one hand a barrier against the activities of the endothelial cells, and on the other hand a distinction of the internal elastic lamina. The endothelial cells accumulate a great number of microvesicles of endocytosis; their content cannot be eliminated through the media and adventitia to the neighbor tissues. An obstruction is created between the process of endocytosis and that of exocytosis and especially that of transcytosis, characteristic for the endothelial cells [6, 7]. In addition, the cells with contorsioned nuclei that transport from the nuclear matrix to the cytoplasm can be disturbed especially the movement of RNAr through nuclear pores, and back from the cytoplasm to the nucleoplasm, the passing of steroid hormones.

The paucity of the microfilaments of actin and myosin in the cytoplasm of the endothelial cells, which normally are in appreciated number, goes off to the destruction of the contractile function of the endothelium, needed for the adjustment of the vascular lumen and the blood circulation.

The formation in excess of the connective tissue in the tunica intima is realized by a stimulation of the function of the fibroblasts present under the endothelial lining and in the same time from the muscle cells of the tunica media. The last one, in the lesion of the tunica intima, synthesized collagen and other proteins of the matrix then stored in the under-endothelial zone, grow thicker this one [8].

The migration of these protein molecules toward the endothelium is favored and lightened by the segmented destructions of the internal elastic lamina, or by his absence in large zones, creating interrupted relations between the endothelial cells and the myocytes of the tunica media. Despite the fact that these myocytes showed a reduced number of myofilaments and a very irregular shape, in general, their ultrastructural organization appeared cvasinormal, facing the great destructions of the tunica media in the cerebral aneurysms. This fact could be related to the existence of a synthesis process in the sarcoplasm, and also to the type of the aneurysm studied, respectively congenital aneurysm of the carotid system, with other peculiarity than those of traumatic, mycotic, syphilitic or other different and more frequent locations.

Conclusions

Arterial wall presents alterations of the ultrastructural organization, by grosisment of the intima, lipid depots as vesicles in the endothelial cellules, and deposed under endothelial and in the media on the vessels. Edema hyaline, fibrosis and inflammatory microzones, are especially between the muscle fibers in the arterial media.

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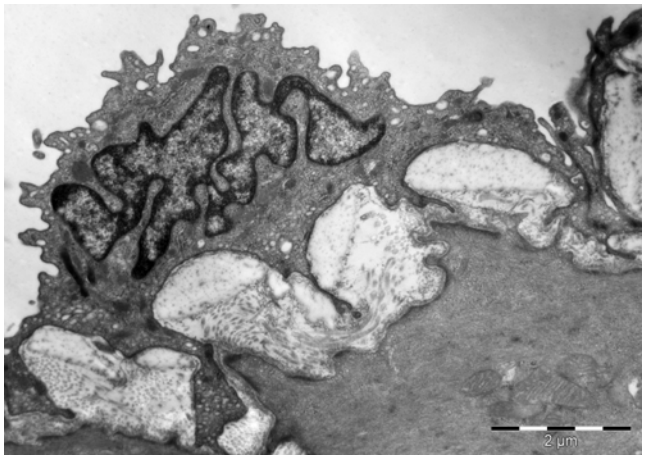


Figure 1 – ***Cerebral aneurysm. Electron microscopy of the arterial wall. The tunica intima shows an endothelial cell with an irregular shape of the nucleus, containing heterochromatin and euchromatin. The cytoplasm and the plasmalemma present frequent evaginations, different in shape and size. Microvesicles and rare cell organelles appear in the cytoplasm. Connective extracellular matrix in great masses is present under the endothelial lining. The internal elastic lamina is segmented. The muscle fibers with irregular shape have few dense bodies and myofilaments. Scale bar = 2 µm***

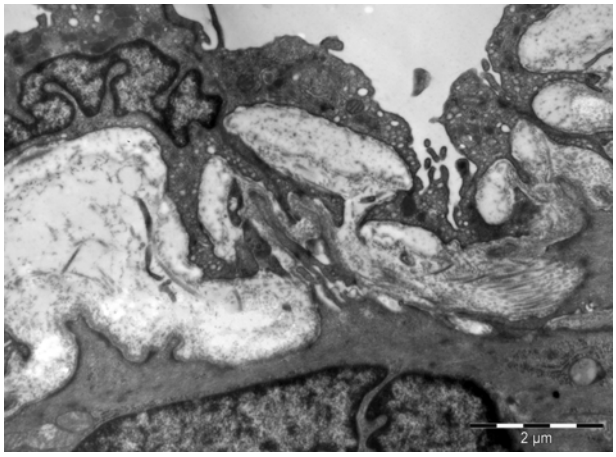
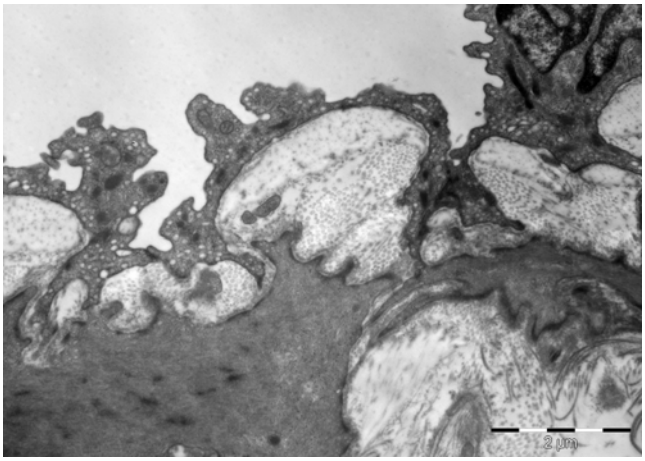


Figure 2 – ***Cerebral carotidian aneurysm. The endothelial tunica from the electron micrograph shows a membrane surface with invaginations and microvili. Light and dense microvesicles are present in the cytoplasm. Large formations of connective extracellular matrix, predominantly with edema, fill the subendothelial space. Fragments of the muscle cell, with few specific and common cell organelles, and segment of the nucleus is near the ruptured internal elastic lamina. Scale bar = 2 µm***

Figure 3 – ***Cerebral aneurysm. Electron micrograph of the arterial wall. The evaginations of the endothelial cell contain numerous microvesicles with light, dense or heterogenous core. The extracellular matrix, as abundant masses, is rich in ground substance and collagen fibrils. Under the internal elastic lamina, partially destroyed, one may observe a fragment of myocyte. Scale bar = 2 µm***



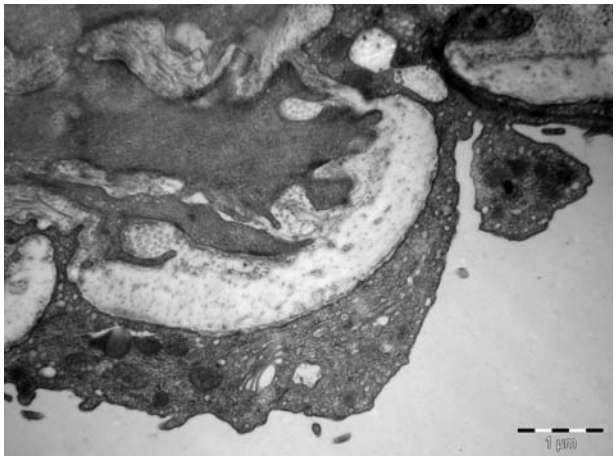


Figure 4 – ***Cerebral aneurysm. Electron micrograph. A large cytoplasmic area of the endothelial cell with numerous light microvesicles, frequent multivesicular bodies, few mitochondria and a Golgi complex are clearly visible. The infiltration of connective extracellular matrix is ample, localized on the internal elastic lamina, with extensively destroyed segments. The muscle fiber has an irregular shape and a reduced number of myofilaments. Scale bar = 1 µm***