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Vascular convolutes in the brain: a peculiar entity

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Abstract

The present study intends to systematically assess a lesion with potential clinical expression – the vascular convolutes of the brain parenchyma. Those, firstly described by Gertz and Frydl in 1987, are frequently reported in various studies as being associated to aging. Their mechanism seems to be an arteriolar tortuosity. The association with pathologically important manifestations, as brain infarct or hemorrhage could be of clinical importance. The study was done on 70 consequently autopsied cases, on paraffin-embedded material, using the classical histological staining methods: Hematoxylin–Eosin and Masson's Trichrome, as well as the Gömöri silver method for reticulum. In our series, only two cases had specific features suggesting vascular convolutes. More frequently were encountered vascular tortuosities, which seems unrelated to the former. We conclude that vascular convolutes and vascular tortuosities are dissimilar lesions. Both are less represented in reality than reported in the literature. Possible mechanisms of the two changes and their pathogenic significance are discussed.

***Keywords*:** vascular convolutes, brain, vascular tortuosities, aging.

Introduction

Vascular changes in the aging brain encompass a large spectrum, from virtually minimal to conspicuous arteriosclerosis, atheroma and their clinical consequences: hemorrhages, infarcts, aneurysms, etc. Some peculiar vascular lesions also exist, that are pointed out in variable ways in different papers.

Such rare features are distortions of small vessels described as vascular convolutes [1, 2] and that are postulated to be frequent in the aging brain.

The underlying mechanism would be a relative shrinkage of the nervous parenchyma at these ages, with subsequent small vessels elongation and distortion.

It seems that this pathology was first described by Cerletti, in the early 20's, and were related to "senile" dementia. Some recent papers confirm the apparition of a degree of tortuosity with advanced age [3].

The arterial hypertension appears to be related to the tortuosity of the arterioles within the white matter [4].

However, recent detailed studies on the microvascularization of the white matter, using multiple approaches, including scanning electron microscopy [5, 6] failed to disclose such modifications.

In our diagnostic experience such modifications are not a current feature, regardless the age of the individual. Therefore, we attempted to assess their real frequency in a comprehensive series of biological samples.

Also, the pathogenic mechanisms or relationship of such morphological changes with some clinical events are ambiguous.

As an example, some degree of unknown chronic local ischemia may be responsible for the apparition of increased amounts of angiogenic factors, with a subsequent small vessel proliferation and/or elongation or, conversely, such a preexistent alteration could generate a lowering in the blood flow with ischemic events as an end result.

Material and methods

Our study was performed on 70 archival cases, on paraffin blocks embedded tissue harvested at the autopsy and/or by surgical biopsy for decompressing purposes.

The cases were originally assessed for various changes: microvascular pathology, amyloid angiopathy, microscopic evaluation of hemorrhage foci or small infarcts and lacunae, etc.

In the present study the paraffin blocks were examined in an unsystematic model as regarding the brain topography, *i.e.* occipital lobe (Brodmann 17th area), insula, frontal lobe (orbital and F2 gyri), hippocampus, brain stem. In each case, a number of minimum four brain regions have been evaluated.

The cause of death was variable, mainly the myocardial infarct, bronchopneumonia or, rarely, massive digestive bleedings or acute herniation of the brain.

The age range was quite large, from 36 to 91 years (mean: 69.28): 41 men, and 29 women (Figure 1).

Classical histological and histochemical stains were performed: Hematoxylin–Eosin, Masson's Trichrome, Gömöri reticulum stain.

Results

The major basic brain pathology of all cases was vascular in nature, with infarcts and hemorrhages as the main aspects. The degree of atrophy of the brain was variable.

The large extra cerebral vessels (the circle of Willis, basilary, sylvian arteries, etc.) had different degrees of common pathological changes: atheroma, hyaline arteriosclerosis, and thrombosis.

The microscopical evaluation of the microvessels in the parenchyma revealed only single vascular lumina, with the same pathology as the larger arteries.

In spite of the great variability in the clinical and pathological data, only two cases showed conspicuous modifications compatible with those described by Gertz and Frydl.

The general histological aspect was a rather poor vascularization of the nervous tissue on routine histological stained samples, either in the white or the gray matter.

The majority of the vessels were of small caliber: 10–40 μm, and capillaries, venules and arterioles are the main components of the vascular tree. Large arteries or veins were very rarely seen within the parenchyma.

According to the age and to the pathological spectrum of the cohort, a large number of the arteriolar vessels and some arteries had arteriosclerotic changes. The latter were represented mainly by the hyaline variant, less frequently by the fibrous one.

Some features suggesting the vascular convolutes, as described by Gertz and Frydl, were encountered only in two cases of the 70 studied (2.85%).

The first was a 56 y/o M (clinical: diabetes mellitus, toxic shock, no arterial hypertension) – biopsy material from surgical decompression for an ischemic accident.

The second one was an 80 y/o F (clinical: arterial hypertension, massive hemorrhage of the hemisphere, deceased).

In these two cases only, of which the first was relatively young, some clusters of vascular, mainly arteriolar lumina, sometimes surrounded by an external limiting membrane, were visible (Figure 2, a–d).

Even though ultrastructural studies were not available, multiple vascular lumina, limited at the periphery by a limiting membrane are conspicuous and highlighted by reticulum stain (Figure 3 – a, b).

On the other hand, vascular tortuosities, as we can depict them correctly in our mind, were present in other different nine cases of the 70 studied (12.85%), aged 47–84 years (mean, 68.44).

In these cases, the pathological associations were: cerebral hemorrhage – five patients, cerebral infarcts – two patients, other systemic conditions (cirrhosis, myocardial infarct) – two patients.

Therefore, 77.7% of these nine cases had cerebral vascular events, mostly hemorrhagic (55.5%). Eight of the nine patients had hypertension.

The caliber of the affected vessels was small, from capillaries to small arterioles, but larger vessel, difficult to identify as arteriolar or venular were also present (Figure 4, a–d).

Discussions

Microvascular structure of the brain was unevenly explored. Some basic histological features are not emphasized anymore in the vast majority of the studies dealing with this topic, even in the great neuropathology textbooks. Various and complex structures, as the perivascular spaces, are mentioned only in older books. As an example, the existence of the artifactual space of Held, or space of His [7] is difficult to be found in modern works, without losing for the meantime its importance in current diagnosis of small vessels pathology. In some recent works, only classical hyaline arteriosclerosis or atheromatosis are emphasized [8].

Vascular convolutes are, from this point of view, another insufficient explored lesion of the brain. Our study attempted to clarify this problem in a series of 70 patients of different ages and having various pathologic brain lesions. The aspects were studied only with conventional stains for practical purposes, related to the normal examination of the nervous tissue in every day neuropathological practice.

In the whole series, only two patients showed such features, although several papers dealing with this subject affirm that is a common feature. The final consequences and nature of such vascular changes are, in our series, unclear, being related to infarcts as well as to hemorrhages.

Another paramount topic is that of the assumption that tortuosities and convolutes are similar. Are these two entities really the same lesion? From our point of view, they are totally different. If an artery can became tortuous, and being associated with a large space around, either form hypertensive or other causes, we believe that it is impossible to it to show, even in an advanced stage, multiple lumina, arranged in bundles, as are the vascular convolutes. The normal distribution of cerebral small arteries is perpendicular one to another, with single lumina originating one from another and no bunches of small arteries are present within a unique sheath. Brain shrinkage could be a possible cause, engendering, at limit, the macroscopical feature called " état criblé" (resembling Swiss cheese). Some mechanical explanations and also a modified activity of the local matrix metalloproteinases (MMP) have been suspected [9].

On the other hand, the great majority of our cases had raised arterial pression, without showing aspects of tortuosity; therefore, a link between the two pathologic elements is not to be expected. Leukoaraiosis and "état criblé", also known as related to arteriolar tortuosity [10], were not present in our series, even in cases with conspicuous tortuous vessels.

The effect of age, however (mean, 68.44 years) could be related to the apparition of some degree of tortuosity in small vessels. Therefore, convolutes seems to be a different, rare change with peculiar aspect, difficult to be related to hypertension or to a specific pathogenesis. Speculations can be done regarding the possibility of a malformative change in some individuals, or the secretion of angiogenic factors in response to chronic ischemic conditions.

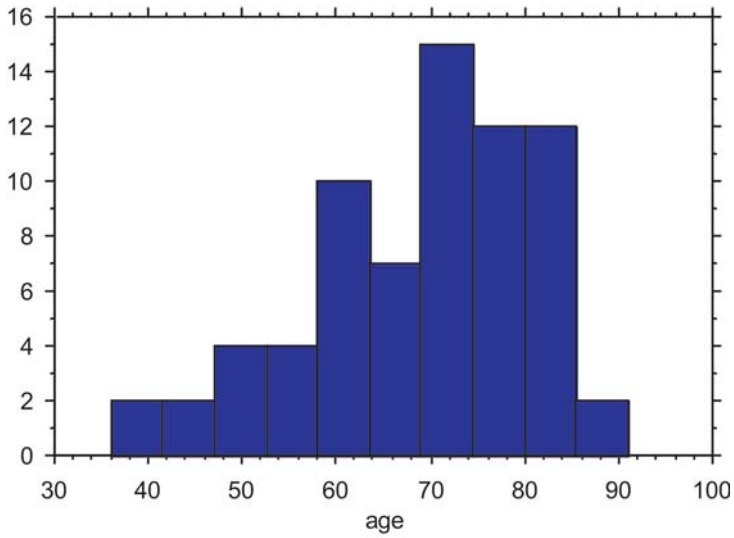

Figure 1 – *Age distribution in the studied cases*

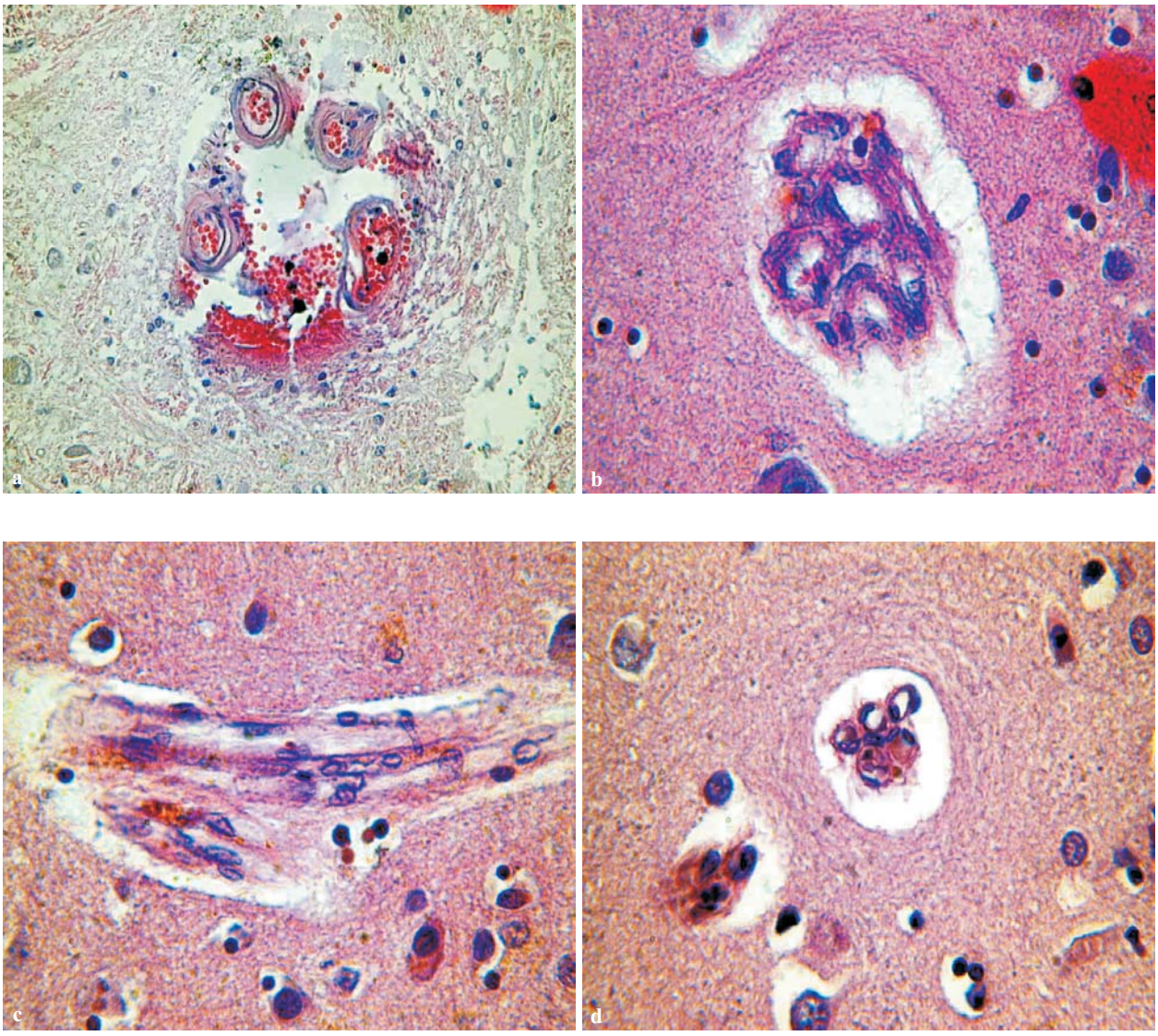

Figure 2 – *Various aspects of vascular convolutes: a) cluster of arterioles within a single surrounding sheath; b) arterioles tightly arranged in a glomeruloid manner; c) longitudinal view of an arteriolar bundle; d) cluster of smaller vessels, near capillary in size (HE staining, original magnification ×20* – **a**, *×100* – **b**, **c**, **d**)

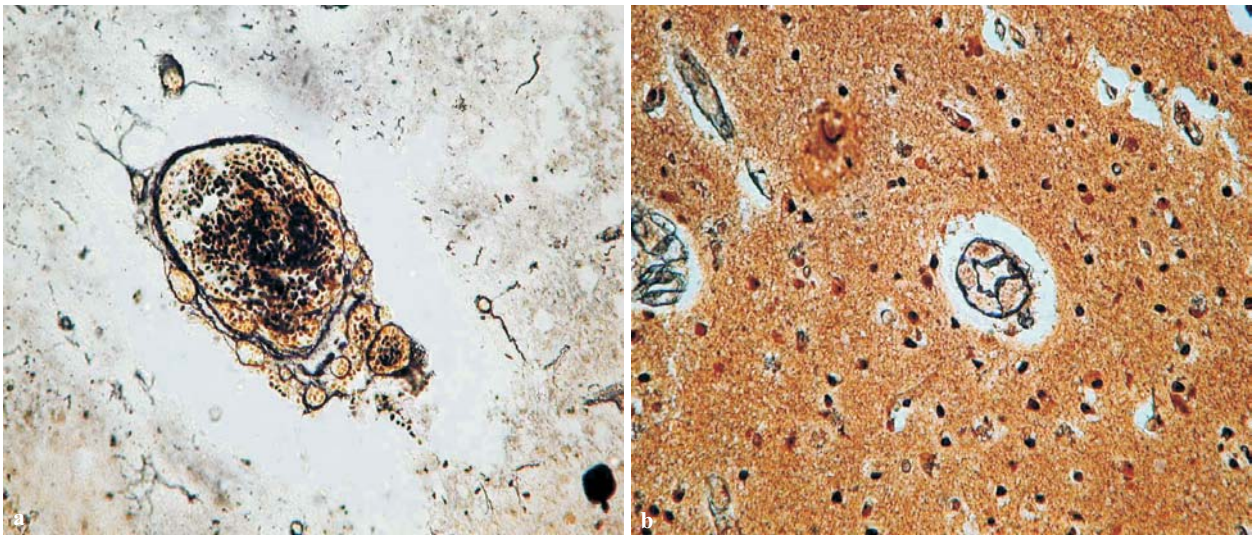

Figure 3 – *Visualization of vessel wall reticulin: a) numerous vessels (at least 10) of extremely various calibers, surrounded by interstitial edema; b) several spaces with peculiar small vessels (center) or aggregated in bundles in different incidences (left) (Gömöri reticulin staining, original magnification ×20* – **a**, *×40* – **b**)

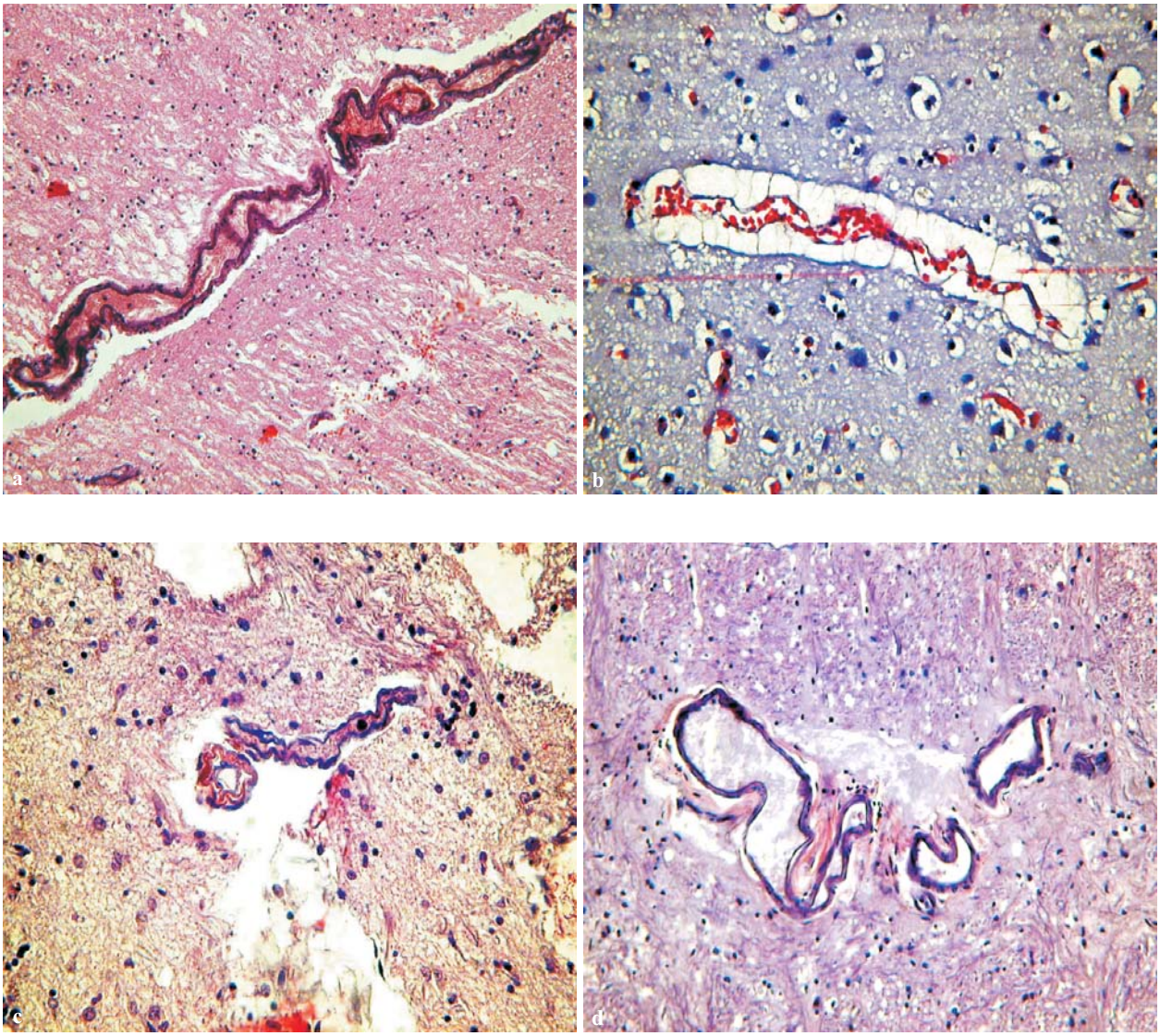

Figure 4 – *a) tortuous arteriole; b) tortuous capillary; c) tortuous arteriole within a cavity, in a case with macroscopical "état criblé"; d) large tortuous vessel, difficult to be identified as an artery or a vein (HE staining, original magnification ×20* – **a**, **d**, *×40* – **b**, **c**)

Conclusions

Vascular convolutes are a rare, peculiar entity with potential malformative origin. Their relationship with stroke or transient ischemic attacks remain unclear.

On the other side, tortuosities are a much common, dissimilar change, possibly related to hypertension, and associated mostly hemorrhagic cerebral events.Further neuropathological studies are required to elucidate the real incidence and clinical associations of each of these two entities.

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