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CASE REPORT

The Cerebral Arterio-Venous Malformations Radiological Portrayal

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ABSTRACT

Increased detection and characterization of incidental cerebral arteriovenous malformations (AVMs) have been documented as a consequence of the more and more recurrent utilization of the most advanced multimodal imaging examinations. The natural history and pathophysiology of cerebral AVM are still not well understood, and its multidisciplinary management is still highly debatable and very controversial. However, the scientific and clinical understanding of cerebral AVMs is practically constantly evolving each and every day. It is clear from previous and current documentation that AVMs can undergo a plethora of very different phenomena, including growth and re-growth, complex and various remodeling, progression, or regression, and all the previously mentioned processes are presumably a combination of both molecular, submolecular, physiological, and pathophysiological mechanisms. A deeper perception and understanding of these complex processes are crucial and of paramount importance to directing future proper and optimal therapeutic approaches. Hereby is represented a 56-years-old subject operated on approximately 40 years ago in Russia due to ruptured aneurysms coming to the tertial health unit due to the sudden onset of complex clinical symptoms (crisis of consciousness, headache in the previous 3 days, left-sided hemiparesis middle-degree in past medical history, with vomiting), with a special focus on cerebral AVM radiological portrayal and also discussing the different imaging techniques at the moment available for detecting cerebral AVMs with reference to the advantages and major drawbacks of each imaging modality and future perspectives in this field. As comprehension and awareness in the field of cerebral AVMs continue to advance and breakthrough, the natural history and predicted clinical and neurological behavior of cerebral AVMs will hopefully become in the nearest future more and more clearly and minutely elucidated.

Keywords: Cerebral arterio-venous malformations, Computed tomography angiography, Simplified supplementary Spetzler-Martin arteriovenous malformations grading scale, The Spetzler-Martin grading scale system, Treatment

A 56-years-old patient operated on approximately 40 years ago in Russia due to ruptured aneurysms is coming to the tertial health unit due to the sudden onset of a crisis of consciousness, headache in the previous 3 days, left-sided hemiparesis, middle degree in past medical history, and vomiting. For the next 3 days, applied therapy was: Sol Mannitol 125 mL/12 h, Dexasone amp. 2×2, Sol NaCl 0.9% 500 mL 2×1, Sabax/Nolpaza/Nexium 1×1 in the morning, and after this applied pharmacotherapy, the subject felt better and was hospitality discharged.

A brain arteriovenous malformation (AVM) (both congenital or acquired) has a very complex angioarchitecture and it is histologically composed

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of a conglomeration of abnormal tortuous vascular vessels (a combination of broad-spectrum diameter well-differentiated arteries and veins to dysplastic vascular channels that are histologically neither artery nor vein) with central nidus without capillary bed and with gliotic non-functional tissue interspersed within the AVM and the surrounding tissues.[1] Radiological evaluation was performed (CT and CTA – Figures 1-3).

Since the major cerebral AVM potential concern and complication is hemorrhage, more grading systems have been inaugurated. Definitely one of the most important, recognized, and used is the Spetzler-Martin grading scale system (SMS; introduced first in 1986),[2] to estimate AVM surgical risk (mainly three features: dimension, relation to the eloquent brain, deep venous drainage presence), later simplified as class A (previously grade I and II): surgically managed; class B (grade III): combined approach but still controversial; and class C (grades IV and V): conservatively managed.[3]

Although digital subtraction angiography (DSA) is the standard of care for AVM diagnosis and follow-up, due to the invasive and risky nature of this procedure, its limited availability, and the advantages of cross-sectional imaging over DSA (precise anatomic localization with a relationship to the surrounding structures, high spatial resolution with multiplanar reformations – MIP and VR), computed tomography angiography (CTA) is therefore considered by many neuroradiologists as the most effective modality in AVM analysis.[4,5] AVMs do not generally expand surrounding tissue through a compressive mass effect but instead tend to replace, rather than displace, central nervous system parenchyma, as in this presented case.[6] Furthermore, in the absenteeism of acute cardiovascular events (thrombosis, embolic events, and/or hemorrhage), AVM has generally only slightly higher attenuation values (HU) than that of the surrounding normal brain parenchyma.[7] Hemorrhage and its mass effect can even further obscure the depiction and detection of an AVM on native CT scans. However, the presence of diffuse calcifications associated with a hematoma most commonly forewarns the neuroradiologist of the possibility of an underlying AVM.[5] In the subset of respondents younger than 20 years, ruptured AVM is reckoned for up to 50% of hemorrhages and even more.[8]

To address the limitations in temporal resolution as an arguable CTA major shortcoming, time-resolved whole-head CTA (also referred to as dynamic 3D CTA or 4D CTA) has been applied to the evaluation of brain AVMs as a co-called cutting-edge radiological technique, ultimately allowing better demarcation of the AVM nidus.[9]

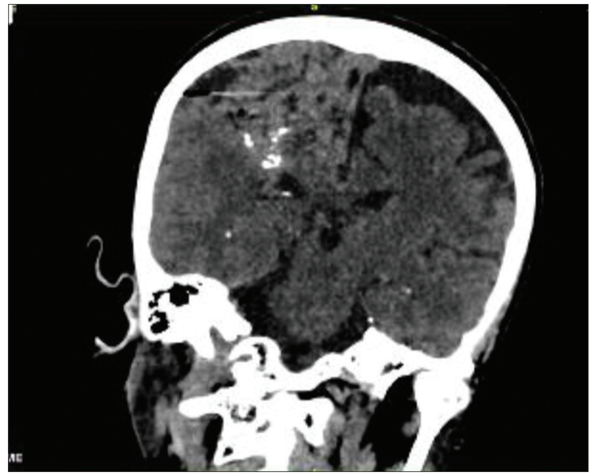

Figure 1: Native endocranial computed tomography, coronal projection: In the right frontoparietal lobes, central nervous system tissue is made of different consistency with multiple calcifications and hypoattenuating zones compared with rest tissue

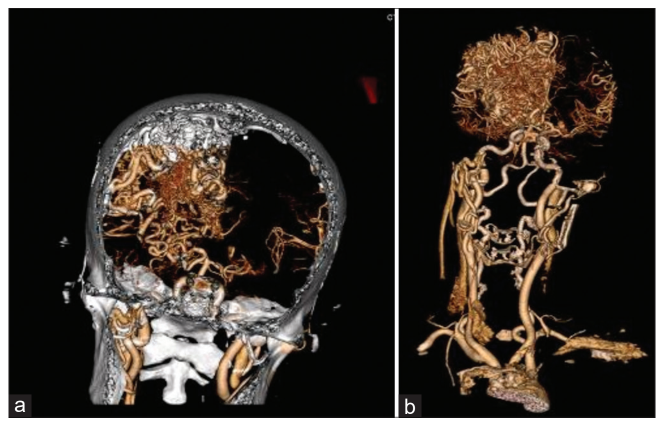

Figure 2: (a) Head-and-neck computed tomography angiography (CTA), Volume rendering, coronal section (a): In the right frontoparietal lobes, pathological conglomerations of abnormal blood vessels like arteriovenous malformation is present, whereas feeders go from the right middle cerebral artery a drainage system goes through the magistral cortical veins in superior sagittal sinus. (b) Head-and-neck CTA, Volume rendering, anteroposterior projection (b): In the right frontoparietal lobes, arterio-venous malformation is present, whereas feeders go from the right middle cerebral artery, a drainage system goes through the magistral cortical veins in the superior sagittal sinus

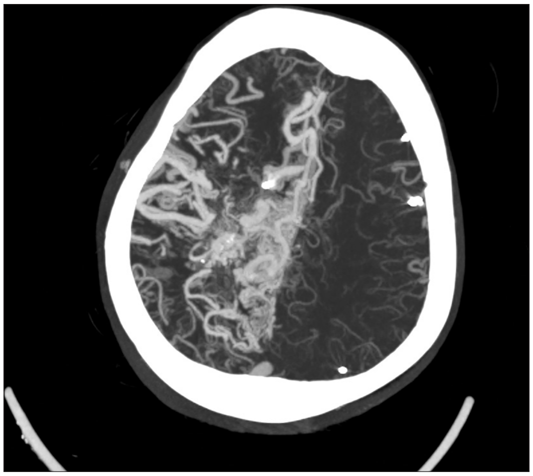

Figure 3: Head and neck computed tomography angiography, MPI – maximum intensity projection, axial section: In the right frontoparietal lobes arterio-venous malformation with nidus and its feeders is present, whereas feeders go from the right middle cerebral artery a drainage system goes through the magistral cortical veins in the superior sagittal sinus

The primary goal of the AVM treatment is an optimally complete excision, mainly to reduce the risk of cerebral hemorrhage. Preservation of the patient's functional status is of paramount importance. Treatment strategies, therefore, include: (1) waitful watching; (2) microsurgery; (3) endovascular management (usually as an adjunct to microsurgical and radiological techniques; also primary therapy for smaller and neurosurgically inaccessible lesions); and (4) radiosurgery, which highly differs from many factors (arguably most importantly from SMS).

Unruptured SMS I and II AVMs in non-eloquent brain areas are most commonly treated with microsurgical approaches, while radiosurgery is by preference modality treatment option for those located in deeply surgically unfavorable anatomy and within the eloquent areas, functionally important zones.

SMS III lesions are rather treated with a combination of microsurgery, embolization, and radiosurgery (it is still highly debatable which treatment approach or combination is the best possible option). The highest-grade changes (SMS IV and V), however, are usually followed up with conservative management.

Of note, in 2010, Lawton *et al*. inaugurated the so-called new and simplified Supplementary Spetzler-Martin AVM grading scale mainly and specifically to predict neurosurgical clinical outcomes, particularly in the field of ruptured cerebral AVM. The supplemented SMS also included rupture status, patient age, deep perforating artery supply, and nidal angioarchitecture (diffuseness versus focal). In a consecutive, single-surgeon series of 300 patients with AVMs treated microsurgically in Lawton's *et al*. 2010 study, the supplemental SMS demonstrated a statistically more significant correlation with post-neurosurgical outcomes than the initial Spetzler-Martin AVM grading system (receiver operating characteristic curve area – ROC 0.78 versus 0.66 as one of the end results, respectively).[10]

This previously mentioned new, more comprehensive cerebral AVM grading system preferably supplements than it replaces the well-established system and is considered a stronger predictor of clinical and neurologic outcomes post-cerebral AVM neurosurgery. The supplementary SMS has proved and documented high predictive accuracy and stratifies post-neurosurgical risk even better. The supplementary SMS is easily applicable in routine and everyday clinical practice, bringing some new and important clinical pieces of information aimed at improving more precise neurosurgical pre-operative risk prediction and refining the proper patient selection, therefore significantly reducing practically all post-operative risks.[10]

CONFLICT OF INTEREST DISCLOSURE

The authors of this paper have nothing to declare.

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