

Spontaneous Regression of Intracranial Arteriovenous Malformation

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Spontaneous regression of an arteriovenous malformation is rare. When complete or partial regression occurs, an associated factor is usually involved, such as intracranial hemorrhage, surgery, radiation therapy, or a new neurological deficit. Another case in which the resolution was totally spontaneous is presented here. We discuss the importance of transcranial doppler revealing the hemodynamic changes in the cerebral arteries in the presence of an AVM and when the latter is thrombosed. Several mechanisms for regression are considered, and we focus on the dissection of the afferent vessel, pointing out the role of such an event in the natural history of AVM.

KEY WORDS: Arteriovenous malformation; Spontaneous thrombosis; Transcranial doppler

Introduction

Spontaneous regression of an arteriovenous malformation (AVM) without intracranial hemorrhage, embolic phenomena of the afferent vessels, coagulopathies, radiation therapy, traumas, or appearance of a neurological deficit is a rare event [24,37,44].

A case of spontaneous and complete disappearance of an intracranial AVM 20 years after diagnosis is reported here. The regression can be confirmed by means of angiographic, tomographic, and doppler sonographic studies.

We emphasize the importance of transcranial doppler (TCD) in the evaluation of the hemodynamic modifications of the AVMs [22]. Analyzing the possible pathogenic mechanisms reported in literature, we point out the likelihood of such an event and its role in the natural history of AVM.

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Case Report

B.B., a 22-year-old man hospitalized in our institute for the first time, had been experiencing generalized seizures with a frequency of two to three times a week for 3-4 months. Neurological examination was negative. Left carotid angiography showed an AVM of 3×2 cm (medium-size AVM) [44] in the left rolandic area fed by the sylvian artery (MCA) of the same side (Figure 1).

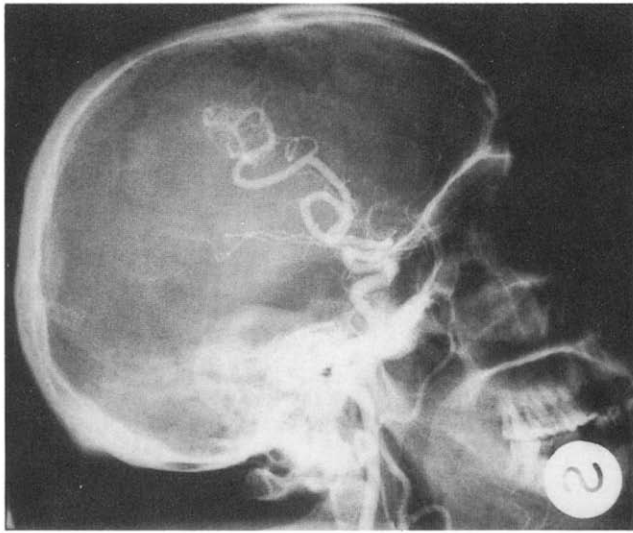
Due to location and size of the angioma, a conservative treatment was chosen and the patient was discharged with antiepileptic treatment (phenobarbital 200 mg/day). "Minor" seizures such as absences were subsequently reported, and, therefore, phenytoin (150 mg/day) was added to the treatment.

At age 36 (14 years later), the patient suffered a further generalized seizure and was readmitted to a hospital. At that time angiography was carried out: the result showed almost no change when compared to the previous one. The patient was discharged with clonazepam (1 mg daily) added to his treatment and no further major or minor seizures occurred.

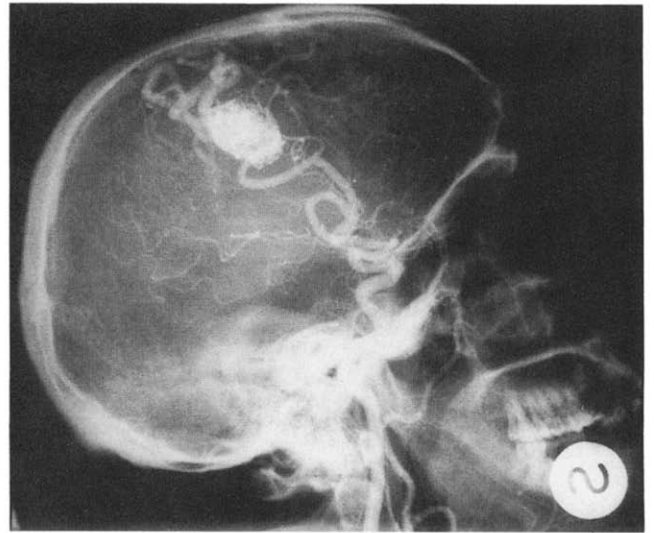
For the following 5 years the patient underwent periodic controls with computed-tomographic (CT) scan and TCD. Hemodynamic study by TCD regularly revealed high-flow velocity on both the left MCA and left anterior cerebral artery (ACA) with vascular resistance (pulsatility index) decreased compared to normal values [22]. The flow direction on the A1 segment of left ACA is inverted, whereas the direction of contralateral flow appears normal but with increased flow velocity. The hyperpnea test did not show any further substantial velocity modifications on the vessels examined (Figure 2).

At 41 years of age the last control of the CT scan exam revealed an area of subcortical impregnation in the left rolandic site with an irregular and partially serpiginous feature (Figure 3).

At age 42, 10 months after the last control, the patient reduced his antiepileptic treatment on his own initiative and was consequently rehospitalized due to the reappearance of generalized seizures. Neurological examination was still negative. CT scan without contrast medium did not reveal any hemorrhage. A TCD control revealed



A



B

Figure 1. (A, B) The left carotid angiography showing an AVM in the left rolandic area fed by a hypertrophic sylvian artery of the same side.

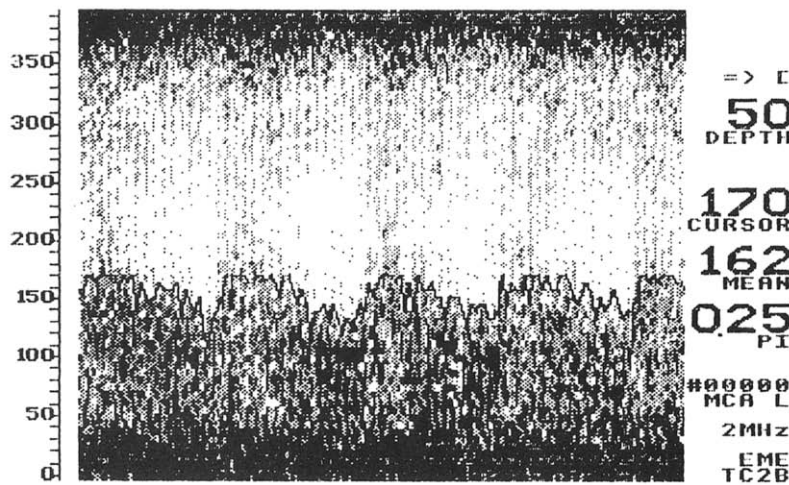
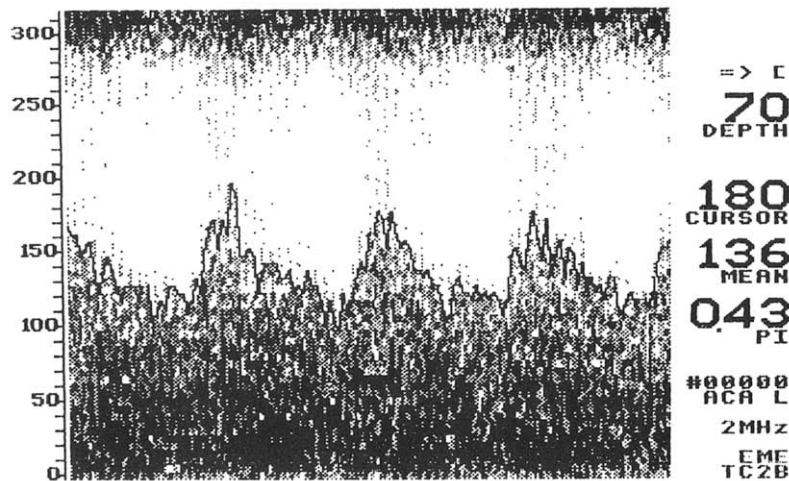


Figure 2. The TCD exam shows increased flow velocities (V_m) and decreased pulsatility index (PI) values on the left MCA (n.v. $V_m 65.6 \pm 8.4$ cm/sec, $PI 0.75 \pm 0.13$) and on the ACA (n.v. $V_m 46.6 \pm 10.2$ cm/sec, $PI 0.68 \pm 0.17$) of the same side. The flow direction on A1 segment of the left ACA is inverted.



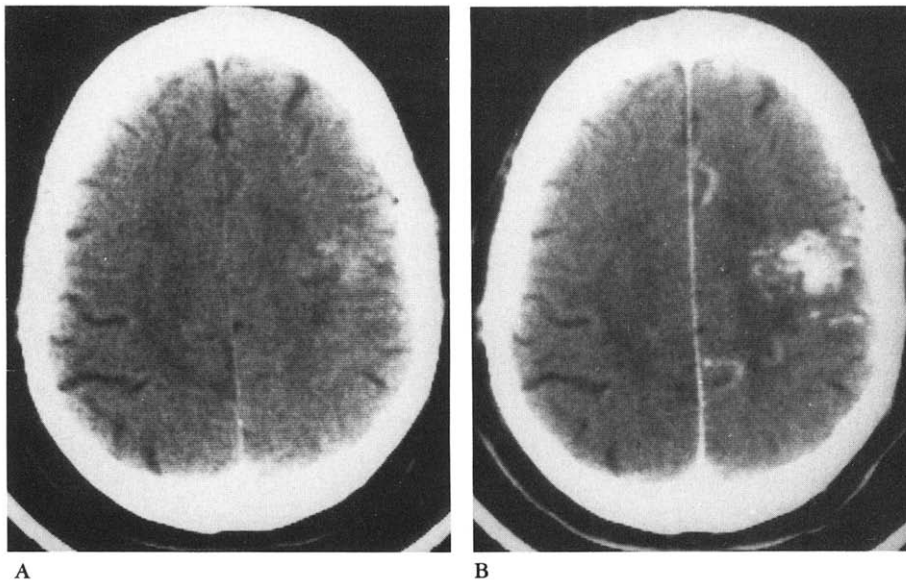
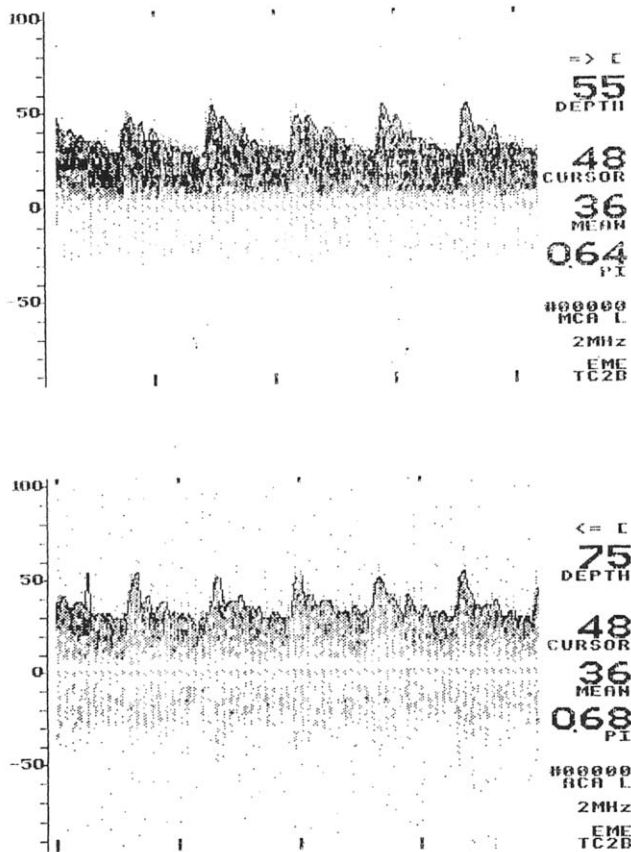


Figure 3. (A, B) The CT scan reveals an area of subcortical impregnation in the left prerolandic site, attributable to the AVM nidus, with irregular and partially serpiginous feature and double images of vessel impregnation which represent the drainage veins toward the superior longitudinal sinus.

normal values of mean flow velocity (Vm) and pulsatility index (PI) on the left MCA and ACA (Figure 4). With the presence of such TCD values, he underwent cerebral angiography through the femoral artery which showed the complete regression of the AVM. A gradually taper-

Figure 4. The TCD exam shows normal values of Vm and PI on the left MCA and ACA.



ing occlusion of the large feeding branch of the MCA near the nidus of the angioma was, in fact, present (Figure 5). He was then discharged with antiepileptic treatment consisting of 200 mg of phenobarbital, 300 mg of phenytoin, and 1.5 mg of clonazepam daily.

At 10 months following his readmission to hospital, TCD exam confirmed normal values of Vm and PI on the left MCA and ACA. A tomographic aspect of a thrombosed AVM [2,3,26,36] was evident in the CT scan (Figure 6). Magnetic resonance imaging (MRI) carried out after 12 months showed in the angioma a small area of linear or ribbon-like aspect with a hypointense signal in every sequence examined (Figure 7). With anti-epileptic treatment, the seizures were controlled.

Discussion

The incidence of partial or complete spontaneous regression in the natural history of AVM is uncertain; according to other authors the percentage value is between 2% and 3% [29,37].

Moreover a complete spontaneous regression has been reported for both intracranial and dural AVM [7,13,21].

Most reported cases of spontaneous regression of AVM have occurred in adults between the ages of 30 and 60 years, at intervals ranging from 6 months to 21 years after diagnosis; in most cases the regression has been acute, whereas a gradual regression (angiographic) of AVM is seen in others [44].

In the literature spontaneous regression has been explained by several mechanisms: Pool and Potts suggest that arteriosclerosis of the feeding vessels could be a possible cause for the spontaneous regression of AVM [32]. Sukoff et al ascribe the disappearance of AVM, in the reported case, to the acute occlusion of the sylvian

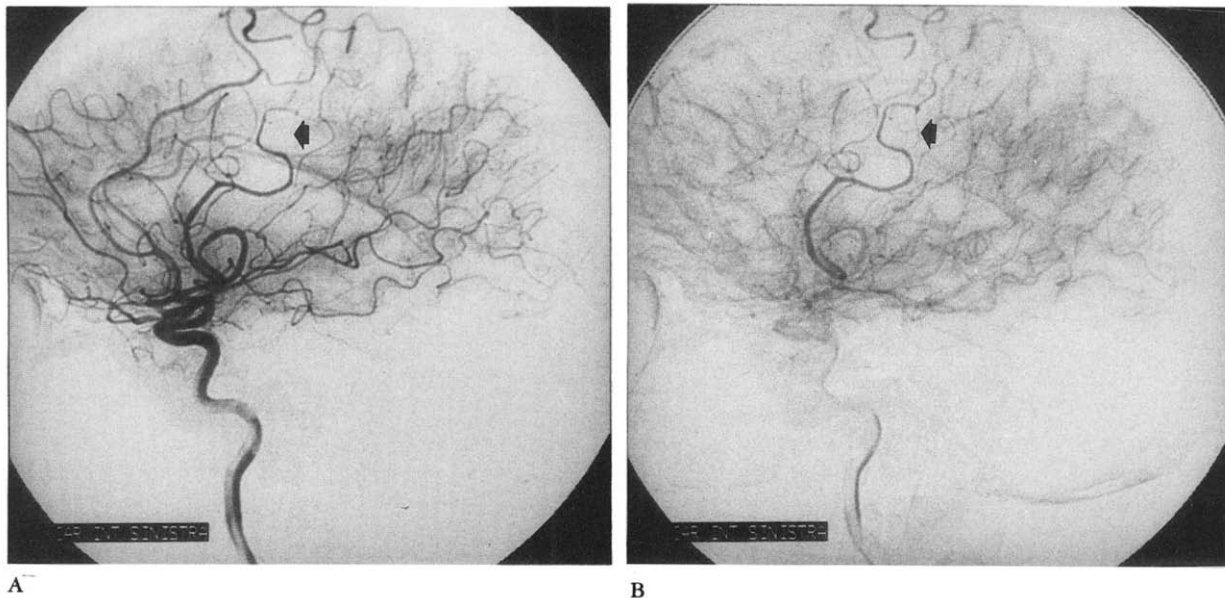
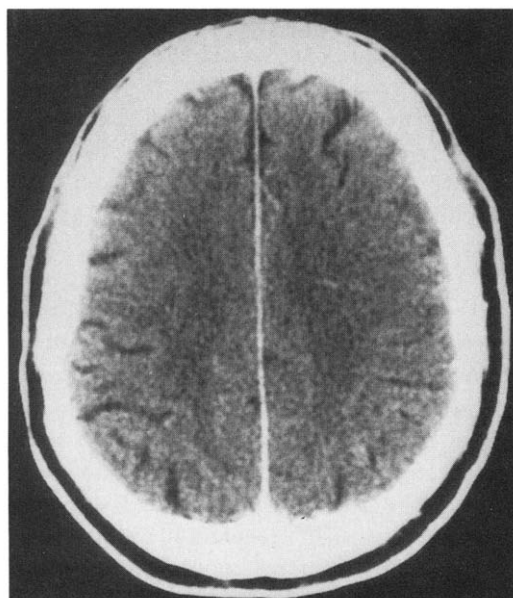


Figure 5. (A, B) The cerebral angiography shows the complete regression of AVM. The feeding vessel of AVM seems to be progressively decreased in caliber (arrows).

artery on an embolic basis [38]. Omoyola et al. state that the partial regression of AVM, in one patient out of the three reported, is a consequence of the embolism starting from an associated thrombosed aneurysm of the feeding vessels [28]. Eisenman et al thought that intra-

Figure 6. CT scan before and after infusion of contrast medium: the characteristic impregnation relative to AVM is no longer evident in the left precentral frontal site.



cranial hemorrhage could lead to the disappearance of an AVM by exerting a compressive force on the AVM directly by the hematoma or indirectly through local edema. The compression reducing the blood flow in the feeding vessels can, in fact, favor thrombosis [6]. Lakke reports a gradual reduction in the size of the afferent vessels observed on serial angiograms. The author hypothesizes that frequent microbleedings with the consequent organization and gliosis of the clot caused kinking of the feeding vessels facilitating thrombosis of the AVM [16]. Conforti suggests that the probability of thrombosis of the dural venous sinuses which has followed a phlebostasis due to an increase of intracranial pressure, could be a mechanism of spontaneous regression of a dural AVM [4].

However, reviewing the cases reported in the literature, the exact mechanisms involved in spontaneous AVM regression are uncertain; the most common is almost certainly that of compression of the vascular nidus from intracranial hemorrhage, either when it is an intracranial hematoma [4,18,20,21,24,30,41] or a subarachnoid hemorrhage [6,7,15,16,40].

On the other hand, other authors say that a total spontaneous regression can occur without hemorrhage and thrombotic phenomena [28,29,33,34,42]. In such cases the partial or total regression of AVM may be demonstrated as an incidental finding on CT or cerebral angiography, either of which is usually carried out for persistent headache or intracranial epileptic seizures.

Even in our patient, the complete disappearance of an AVM diagnosed about 20 years previously was an incidental finding that occurred during a dopplersonographic and angiographic control for seizures. Such a

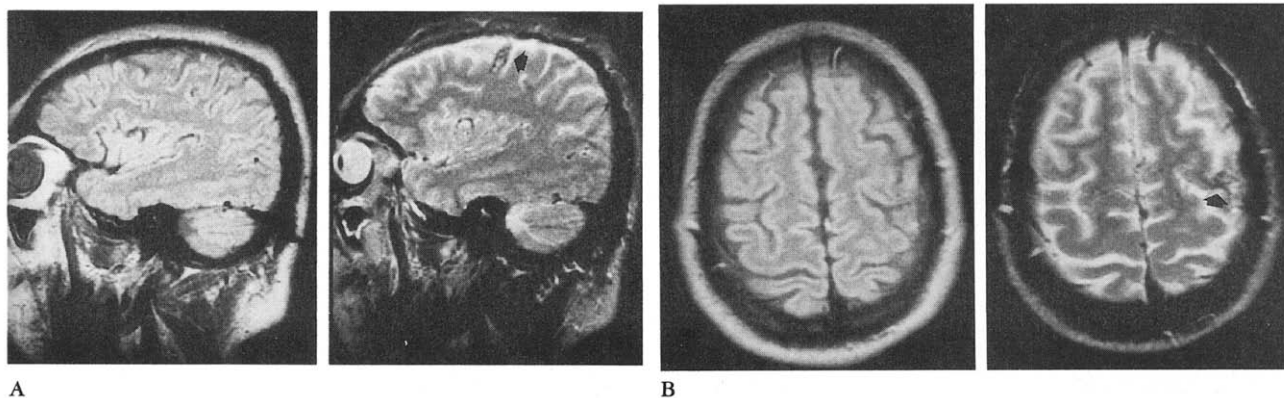


Figure 7. (A, B) Magnetic resonance DP- and T2-weighted images (SE, TR/TE 1876/130 and TR/TE 1876/100): on the left precentral frontal region with sulcal distribution a small long area of hypointense signal, prevalently in T2-weighted images, is present (arrows). Vascular-type images cannot be documented.

phenomenon, in the absence of any other "favoring factor" should be considered a spontaneous regression.

It is difficult to specify the mechanism by which AVM thrombosis occurred and only hypotheses can be suggested. The CT scan without contrast medium performed on the patient upon his admission to the hospital for epileptic seizures did not give any signs of hemorrhage; angiography revealed a thrombosed AVM. About 10 months prior to this, the AVM had very clearly showed up on both the CT scan and TCD. During the interval of time following these examinations, no neurologic symptomatology was observed to make us suspect hemodynamic modifications in AVM. As a matter of fact, once the seizures had been controlled by antiepileptic treatment and once CT scan had ruled out the possibility of hemorrhage, angiographic study would not have been performed to verify a disappearance of the arteriovenous shunt if TCD had not revealed a normal velocity flow on the left MCA and ACA which fed the AVM.

Nevertheless, MR imaging carried out 12 months after this period of seizures showed a small area, linear in aspect, and of hypointense signal in every sequence examined that could be interpreted as a hemorrhage in the AVM. Such a hemorrhage, however, it came about, must have been of a small dimension considering that no neurologic manifestations or even headache were reported. However, it must be noted that the hemorrhage evolves toward a "cyst-like" MR aspect [10]. Moreover the small hypointense area revealed by MR imaging, due to hemosiderin deposits, could be mistaken for two other entities: dense calcifications and flow void (lack of signal) in vessels [10]. Calcium deposits are excluded by CT scan, and flow void is excluded by angiographic findings.

The angiographic picture of a progressive narrowing of the feeding vessel lumen up to its obstruction in the nidus of the angioma is very interesting for a mechanism

of feeding vessel dissection. This pathogenic mechanism is quoted elsewhere by various authors, who point out in the "hemodynamic stress" that the angioma vessels must bear the *primum movens* of the histopathological alterations of the walls themselves. The high blood flow, often characterized by turbulent movement, would, as a matter of fact, determine hypertrophy and successive vessel dilatation [1,8,12,23,25]. Stress would also imply endothelial alterations and dissection of the intima with consequent stenosis, vessel obstruction, or the formation of aneurysms on the afferent vessel to the angioma [11,17,24,35,39]. This case is interesting not only because of the phenomenon of spontaneous thrombosed AVM of such dimension and with such high blood flow in the feeding vessels, but also because it underlines the usefulness of TCD in the evaluation of the hemodynamic situation of an arteriovenous shunt and its eventual modifications [14,19]. TCD examination had already proved to be useful for measuring increases in flow velocity on the left MCA and ACA (in which the flow was inverted) for the presence of shunt with reduced cerebrovascular resistance which were not modifiable at hyperpnea due to the vasoparalysis phenomena [22]. This hemodynamic situation remained unaltered for 5 years at least. TCD exam, however, proved to be more useful in revealing normalization in flow velocity on the vessels that fed the AVM to such an extent as to make us suspect a thrombosis of the shunt, and suggest that angiographic study should be performed to confirm the phenomenon. Without the TCD exam finding the normalization of the right hemisphere's cerebral hemodynamic situation, after the control of the seizures and exclusion of hemorrhage at CT scan, there would have been no reason to perform angiography.

The almost complete disappearance of epileptic seizures after the setup of the treatment, taking into account the rarity of bleeding in the natural history of

thrombosed AVM [44], led us to decide against surgical removal as suggested by Wharen et al for these cases with intractable seizure disorders [42].

On the other hand the criteria for advising surgery for an arteriovenous malformation must prescind from the possibility of spontaneous regression which is a rare event; the age and general status of the patient as well as the site and size of the AVM are important [5,6,9,27,31,43].

We considered it important to report this case because a careful study of the spontaneous regression can help establish the possible treatment. Additionally, in the follow-up of patients with a non-treated AVM, the importance of TCD, a bloodless and repeatable exam, for the evaluation of spontaneous regression is pointed out.

References

1. Bailey OT. The vascular component of congenital malformations in the central nervous system. *J Neuropathol Exp Neurol* 1961; 20:170-84.
2. Bell BA, Kendall BE, Symon L. Angiographically occult arteriovenous malformations of the brain. *J Neurol Neurosurg Psychiatry* 1978;41:1057-64.
3. Castaigne P, Buge A, Pertuiset B, Laplane D, Corbin J. Angiome thrombosé radiologiquement exclu. *Bul Mém Soc Méd Hop Paris* 1961;77:923-30.
4. Conforti P. Spontaneous disappearance of cerebral arteriovenous angioma. *J Neurosurg* 1971;34:432-4.
5. Drake CG. Cerebral arteriovenous malformations: Considerations for and experience with surgical treatment in 166 cases. *Clin Neurosurg* 1979;26:145-52.
6. Eisenman JL, Alekoubides A, Pribam H. Spontaneous thrombosis of vascular malformations of the brain. *Acta Radiol (Diagn)* 1972;13:77-85.
7. Endo S, Koshu K, Suzuki J. Spontaneous regression of posterior fossa dural arteriovenous malformation. *J Neurosurg* 1979;51: 715-7.
8. Folkow B, Siverstsson R. Adaptive changes in "reactivity" and wall/lumen ratio in cat blood vessels exposed to prolonged transmural pressure difference. *Life Sci* 1968;7:1283-9.
9. Garretson HD. Intracranial arteriovenous malformations. In: Wilkins RH, Rengachary SS, eds. *Neurosurgery*, Vol 2. New York: McGraw-Hill Book Company, 1985:1448-58.
10. Gomori JM, Grossman RI, Goldberg HI, Hackey JM, Zimmerman RA, Bilaniuk LT. Occult cerebral vascular malformations: High-field MR imaging. *Radiology* 1986;158:707-13.
11. Hayashi S, Arimoto T, Itakura T, Fujii T, Nishiguchi T, Komai N. The association of intracranial aneurysms and arteriovenous malformation of the brain. *J Neurosurg* 1981;97:1-5.
12. Kaplan HA, Aronson SM, Browder EJ. Vascular malformations of the brain. An anatomical study. *J Neurosurg* 1961;18:630-40.
13. Kataoka K, Taneda M. Angiographic disappearance of multiple dural arteriovenous malformations. *J Neurosurg* 1984;60: 1275-8.
14. Keller HM. Diagnosis and follow-up of patients with cerebral AVM using Doppler ultrasound. In: Yasargil MG, ed. *Microneurosurgery*, Vol. IIIA. Stuttgart-New York: Thieme Verlag, 1987:240-9.
15. Kushner J, Alexander E. Partial spontaneous regressive arteriovenous malformation. *J Neurosurg* 1970;32:360-6.
16. Lakke JPDF. Regression of an arteriovenous malformation of the brain. *J Neurol Sci* 1970;11:489-96.
17. Leo JS, Lin JP, Kricheff II. Pseudoaneurysm formation secondary to spontaneous thrombosis of a massive cerebral arteriovenous malformation. *Neuroradiology* 1979;17:115-9.
18. Levine J, Misko JC, Seres JL, Snodgrass TA. Spontaneous angiographic disappearance of a cerebral arteriovenous malformation. *Arch Neurol* 1973;28:195-6.
19. Lindegaard KF, Grolimund P, Aaslid R, Nornes H. Evaluation of cerebral AVM's using transcranial Doppler ultrasound. *J Neurosurg* 1986;65:335-44.
20. Mabe H, Furuse M. Spontaneous disappearance of a cerebral arteriovenous malformation in infancy. *J Neurosurg* 1977;46:811-5.
21. Magidson MA, Weinberg PE. Spontaneous closure of dural arteriovenous malformation. *Surg Neurol* 1976;6:107-10.
22. Marconi F, Parenti G. The role of TCD in hemodynamic evaluation of cerebral AVMs. *J Neurosurg Sci* 1991;4:199-205.
23. McCormick WF. Pathology of vascular malformations of the brain. In: Wilson CB, Stein BM, eds. *Intracranial arteriovenous malformations*. Baltimore/London: Williams & Wilkins, 1984:44-63.
24. Nehls DG, Pittman HW. Spontaneous regression of arteriovenous malformations. *Neurosurgery* 1982;11:776-80.
25. Nornes H. Quantitation of altered hemodynamics. In: Wilson CB, Stein BM, eds. *Intracranial arteriovenous malformations*. Baltimore/London: Williams & Wilkins, 1984:32-43.
26. Ogilvy CS, Heros RC, Ojemann RG, New PF. Angiographically occult arteriovenous malformations. *J Neurosurg* 1988;69:350-5.
27. Olivecrona H, Riives J. Arteriovenous aneurysms of the brain. Their diagnosis and treatment. *Arch Neurol Psychiatry* 1948;59:567-602.
28. Omojola MF, Fox AJ, Vinuela FV, Drake CG. Spontaneous regression of intracranial arteriovenous malformations. *J Neurosurg* 1982;57:818-22.
29. Pasqualin A, Vivenza C, Rosta L, Scienza R, Da Pian R, Colangeli M. Spontaneous disappearance of intracranial arterio-venous malformations. *Acta Neurochirurgica* 1985;76:50-7.
30. Pecker J, Sabouraud O, Javalet A. Les Thromboses spontanées des anévrysmes artério-veineux cérébraux. *Neuro-chirurgie* 1961;7:155-7.
31. Perret G, Nishioka H. Report on the cooperative study of intracranial aneurysm and subarachnoidal hemorrhage: Arteriovenous malformations: An analysis of 545 cases of craniocerebral arteriovenous malformations and fistulae reported to the cooperative study. *J Neurosurg* 1966;467-490.
32. Pool JL, Potts DG. Aneurysms and arteriovenous anomalies of the brain. Diagnosis and treatment. New York: Harper and Row, 1965.
33. Sartor K. Spontaneous closure of cerebral arteriovenous malformation demonstrated by angiography and computed tomography. *Neuroradiology* 1978;15:95-8.
34. Sasaki U, Itagaki T, Shimizu H, Takahashi M. Almost complete regression of cerebral arteriovenous malformation: Report of a case. *No Shinkei Geka* 1976;4:175-8.
35. Shenkin HA, Jenkins F, Kim K. Arteriovenous anomaly of the brain associated with cerebral aneurysm. *J Neurosurg* 1971;34:225-8.
36. Shuey HM, Day AL, Quisling RG, Sypert GW. Angiographically cryptic cerebrovascular malformations. *Neurosurgery* 1979;5:476-9.
37. Stein BM. Arteriovenous malformations of the cerebral convexities. In: Wilson CB, Stein BM, eds. *Intracranial arteriovenous malformations*. Baltimore: Williams & Wilkins 1984:156-83.
38. Sukoff MH, Barth B, Moran T. Spontaneous occlusion of a mas-

- sive arteriovenous malformation. Case report. *Neuroradiology* 1972;4:121-3.
39. Suzuki J, Onuma T. Intracranial aneurysms associated with arteriovenous malformations. *J Neurosurg* 1979;50:742-6.
40. Svien HJ, Peserico L. Regression in size of arteriovenous anomaly. *J Neurosurg* 1960;17:493-6.
41. Wakai S, Chen CH, Wu KY, Chiu SW. Spontaneous regression of a cerebral arteriovenous malformation. *Arch Neurol* 1983;40:377-80.
42. Wharen RE, Scheithauer BW, Laws ER. Thrombosed arteriovenous malformations of the brain. An important entity in the differential diagnosis of intractable focal seizure disorders. *J Neurosurg* 1982;57:520-6.
43. Wilson CB, Hoi-Sang U, Domingue J. Microsurgical treatment of intracranial vascular malformations. *J Neurosurg* 1979;51:446-54.
44. Yasargil MG. *Microneurosurgery*. Stuttgart-New York: Georg Thieme Verlag, York, 1987.