Original Paper

Spontaneous Thrombosis of a Ruptured Brain Arteriovenous Malformation: The Argument for Early Conservative Management

Nitin Goyal^a Daniel Hoit^{b, c} Lucas Eljovich^{a-c}Departments of ^aNeurology and ^bNeurosurgery, University of Tennessee Health Sciences Center, and ^cSemmes-Murphey Neurologic and Spine Institute, Memphis, Tenn., USA**Key Words**

Arteriovenous malformations · Intracranial hemorrhage · Arteriovenous malformation ruptures · Spontaneous thrombosis · Cerebrovascular hemorrhage

Abstract

Generally, definitive treatment of brain arteriovenous malformations (BAVM) presenting with hemorrhage is recommended to prevent recurrent hemorrhage. The risk of craniotomy and resection of BAVM has been well described using the Spetzler-Martin grading scale; however, the optimal timing for the definitive treatment of ruptured BAVM remains unclear. We report an interesting case of spontaneous BAVM thrombosis in which the patient presented with right occipital intracerebral hemorrhage caused by ruptured right occipital micro-BAVM. A preoperative angiogram 4 months later demonstrated spontaneous thrombosis of the AVM. Despite the risk of re-bleeding, the decision to defer treatment in the acute stage of illness in this case was based on the absence of high-risk angioarchitectural features in the arteriovenous malformations (AVM). It is important to emphasize the potential benefits of early conservative management, particularly in patients with low-risk angiographic features. We also review the literature of spontaneous BAVM thrombosis and discuss the potential benefit of early conservative management.

© 2015 S. Karger AG, Basel

Introduction

Brain arteriovenous malformations (BAVM) are abnormal connections of venous and arterial systems without intervening capillary network. They occur in 0.1% of the population [1], with the prevalence in adults being approximately 18/100,000. The usual age range of presentation is 10–40 years, and the most common clinical presentation is intracranial hemor-

Lucas Eljovich, MD
Semmes-Murphey Neurologic and Spine Institute
6325 Humphreys Blvd
Memphis, TN 38120 (USA)
E-Mail leljovich@semmes-murphey.com

rhage followed by seizure, headache, and focal neurological deficits. Clinical presentation varies with size, location, and other angioarchitectural features of arteriovenous malformations (AVM), including the presence of intranidal aneurysms and venous outflow restriction [2].

Definitive treatment of BAVM presenting with hemorrhage is generally recommended to prevent recurrent hemorrhage. The risk of craniotomy and resection of BAVM has been well described using the Spetzler-Martin grading scale [3]; however, the optimal timing for the definitive treatment of ruptured BAVM remains unclear. Spontaneous angiographic regression has been seen in <1.5% of all BAVM [4].

In this report, we present a case of a ruptured BAVM that was treated conservatively in the acute period and subsequently underwent spontaneous thrombosis. We reviewed the literature on BAVM spontaneous thrombosis and discuss the potential benefit of early conservative management.

Case Report

A 32-year-old African-American female with a medical history of non-insulin-dependent diabetes mellitus presented with sudden onset of headache and blurred vision. Home medications included metformin, aspirin, and oral contraceptives. Neurological examination demonstrated a left inferior quadrantanopsia. CT and MRI of the brain revealed a right occipital intracerebral hemorrhage (ICH). She was initially managed in the neurocritical care unit with supportive treatment and blood pressure control. Subsequent digital subtraction angiography demonstrated a right occipital micro-BAVM (Spetzler-Martin grade 2) with involvement of the eloquent visual cortex (fig. 1). The patient was discharged home with normalization of her visual field, with formal Goldman perimetry testing on clinic follow-up. Available treatment options were discussed with the patient. She returned 4 months later for planned angiography and resection of the AVM, but a repeat preoperative angiogram demonstrated spontaneous thrombosis of the AVM (fig. 2).

Methods

We conducted a PubMed search from 1955 to 2013 of cases with the following search terms: spontaneous regression; disappearance; thrombosis of brain AV malformation associated with intracerebral (ICH); subarachnoid (SAH), and intraventricular hemorrhage (IVH) (table 1). Data describing age, sex, presentation, location of AVM, number of arterial feeders, venous drainage outlets, and size of the nidus were obtained from the search results [4–28].

Results

In our review, 47 cases of spontaneous regression, disappearance, and/or thrombosis of a BAVM associated with rupture at presentation have been reported. Out of these 47 cases, 26 (55.31%) included male patients and 21 (44.68%) included female patients. The mean age was 38 with a range of 10–65 years. Thirteen patients presented with SAH, 21 patients presented with ICH, 9 patients presented with IVH, and 4 patients presented with multiple compartment hemorrhage (any combination of ICH, SAH, or IVH). The location of AVM hemorrhages were frontal lobe [8], parietal lobe [14], occipital lobe in 5, and cerebellar hemisphere in 4 patients. Twenty-five patients (59.5%) had a single arterial feeder to AVM, while 18 patients had multiple arterial feeders (41.0%). In 4 patients, arterial feeders were not reported. Thirty-two patients (82.0%) were found to have single venous drainage from the AVM. In 8 patients, venous drainage was not reported. The size of the AVM nidus was ≤ 3 cm in 27 out of 31 patients (87.1%) for whom the size of the nidus was given. Only 4 patients (12.9%) were reported to have a nidus size of >3 cm.

Fig. 1. **a** Head CT without contrast demonstrates a right occipital hemorrhage. **b** A sagittal T1-weighted brain MRI without contrast demonstrates an isodense hematoma in the right occipital lobe. A left vertebral digital subtraction angiogram lateral projection in the arterial (**c**), late arterial (**d**), and capillary phase (**e**) demonstrates a micro-AVM nidus (black arrow) fed by the cortical branch of the calcarine artery. The draining cortical vein (dashed arrows) is seen in the arterial phase with capillary filling defect, indicating the adjacent hematoma.

Fig. 2. Left vertebral artery digital subtraction angiography. Arterial (**a**), mid-arterial (**b**), and capillary (**c**) phase images demonstrate no evidence of arteriovenous shunting.

Table 1. Results of BAVM case report literature search in PubMed

First author [ref.], year	Patient age, years	Patient gender	Presentation	Location of AVM	Arterial feeder(s)	Venous outflow(s)	Size of nidus, cm
De Lange [5], 1955	64	F	SAH	occipital	single	single	3.5
Kushner [6], 1970	53	M	SAH	frontal	single	multiple	unreported
Conforti [7], 1971	37	F	SAH	frontal	single	single	unreported
Eisenman [8], 1972	34	F	SAH	parietal	unreported	single	unreported
Levine [9], 1973	40	M	ICH	parietal	single	unreported	unreported
Heeres [10], 1976	34	M	SAH	frontal	unreported	single	unreported
Sasaki [11], 1976	57	M	ICH	parietal	multiple	single	unreported
Miyazaki [12], 1978	46	M	SAH	parietal	single	multiple	3.5
Sartor [13], 1978	24	F	ICH	basal ganglia	single	unreported	unreported
Nukui [14], 1982	54	M	SAH	occipital	single	single	1.4
	26	M	ICH	parietal	single	single	7
Omojola [15], 1982	40	F	ICH	parietal	single	single	unreported
Wakai [16], 1983	17	M	SAH	frontal	multiple	multiple	4
Pasqualin [17], 1985	16	M	ICH	parietal	single	unreported	<2
Takano [18], 1987	65	M	ICH	parietal	single	single	2
Gibb [19], 1988	15	F	SAH	basal ganglia	multiple	multiple	unreported
Minakawa [20], 1989	34	M	ICH	parietal	single	unreported	unreported
	32	M	ICH	parietal	single	unreported	unreported
	32	M	ICH	parietal	single	unreported	unreported
Salpietro [21], 1989	35	F	SAH	parietal	single	single	unreported
Barker [22], 1990	23	F	IVH	parietal	single	multiple	unreported
Ezura [23], 1992	59	M	ICH	occipital	multiple	multiple	unreported
Mizutani [24], 1995	59	M	SAH	frontal	multiple	single	unreported
Abdulrauf [4], 1999	28	M	IVH	cerebellum	multiple	single	<3
	35	M	IVH	parietal	unreported	single	3
	37	F	ICH	thalamus	single	single	2
Patel [25], 2001	42	F	ICH/IVH/SAH	corpus callosum	single	single	<1
	55	F	SAH	corpus callosum	single	single	1.5
	18	F	IVH	foramen of Monro	multiple	single	<1
	44	M	ICH	midbrain	multiple	single	<1
	41	M	ICH	occipital	single	single	<1
	30	F	IVH	thalamus	multiple	single	<1
	30	F	IVH	frontal	single	single	<1
	43	M	IVH	internal capsule	single	unreported	<1
	52	F	ICH/IVH	central white matter	multiple	single	1.5
	13	M	ICH/IVH	thalamus	multiple	single	<1
	51	F	IVH	temporal	multiple	single	1.5
	52	F	ICH	cerebellum	multiple	single	<1
	19	F	ICH	frontal	multiple	single	<1
	48	M	ICH	suprasellar	unreported	single	1.5
	10	F	SAH	frontal	single	single	<1
	42	F	IVH	thalamus	multiple	single	<1
Lee [26], 2002	36	M	ICH	basal ganglia	multiple	single	<3
	28	F	ICH	occipital	single	single	<3
	55	M	ICH/IVH	basal ganglia	multiple	single	<3
Cloft [27], 2002	20	M	ICH	cerebellum	single	unreported	1
Panciani [28], 2008	65	M	ICH	cerebellum	multiple	multiple	1.5

Discussion

The natural history of BAVM has been well described in a meta-analysis done by Gross and Du [29]. In their analysis, the overall annual hemorrhage rate for BAVM was reported to be 3.0%, with a low risk of 2.2% for unruptured AVM and a high risk of 4.5% for ruptured AVM. Ondra et al. [30] reported an annual re-bleeding rate of 4.0%. Yamada et al. [31] demonstrated an annual rate of bleeding after initial hemorrhage of 6.8%, with the highest rate of 15.4% in the first year, 5.32% in the subsequent 4 years, and 1.72% after 5 years. Patients presenting with seizures and other neurological deficits had a lower risk of hemorrhage [31]. Angiographic features associated with an increased risk of hemorrhage include a large nidus size, a deep location of the AVM, deep venous drainage, and associated aneurysm [32].

Our review of the literature regarding spontaneous BAVM thrombosis highlights many of the same clinical and angiographic characteristics seen in this case. The presence of single arterial feeders or venous drainage, a small (i.e., <3 cm) nidus size, and mass effect caused by ICH were common in previous reports, all of which were found in our case. The most common of the above-mentioned characteristics is the presence of a single draining vein, which was reported in 82.0% of the patients. Mass effect from the hematoma may cause partial or complete occlusion of the draining vein leading to blood stasis and potential thrombosis of AVM. The presence of a hematoma and the use of oral contraceptives – both previously reported to cause hypercoagulability and thrombosis by mechanical and hormonal mechanisms – may also play a role in spontaneous thrombosis [33, 34].

The annual rate of bleeding can be as high as 34.4% for the patient group with the combination of hemorrhagic presentation, deep location, and deep venous drainage [35]. Our patient with BAVM presented with hemorrhage but did not have other high-risk morphological features, which suggested that definitive treatment is required but not necessarily during the same hospitalization. Therefore, despite the risk of re-bleeding, it was decided to defer treatment in the acute stage of illness. Additionally, the large size of the hematoma relative to the visualized nidus suggested that the entire lesion may not be visualized due to mass effect. Incomplete visualization of the lesion has the potential to complicate surgery, particularly due to the eloquent location of the lesion in the primary visual cortex.

Conclusion

Spontaneous thrombosis of BAVM is associated with several well-described angioarchitectural and clinical characteristics, yet it remains an extremely rare and unpredictable phenomenon. Given the significant potential morbidity of any of the available treatment modalities for BAVM, spontaneous thrombosis should be regarded as a fortuitous event that may represent the most elegant resolution to a dangerous pathology. Therefore, it is important to recognize the potential benefits of early conservative management, particularly in patients with low-risk angiographic features.

Acknowledgments

The authors wish to thank Andrew J. Gienapp for technical and copy editing, the preparation of the manuscript and figures for publishing, and publication assistance with this paper.

Disclosure Statement

Dr. Goyal has no financial relationships to disclose. Dr. Eljovich has served as a consultant for Stryker Neurovascular, Microvention, and Codman Neurovascular. Dr. Hoit has served as a consultant for Covidien.

References

- 1 Al-Shahi R, Warlow C: A systematic review of the frequency and prognosis of arteriovenous malformations of the brain in adults. *Brain* 2001;124:1900–1926.
- 2 Garcin B, Houdart E, Porcher R, Manchon E, Saint-Maurice JP, Bresson D, et al: Epileptic seizures at initial presentation in patients with brain arteriovenous malformation. *Neurology* 2012;78:626–631.
- 3 Spetzler RF, Martin NA: A proposed grading system for arteriovenous malformations. *J Neurosurg* 1986;65:476–483.
- 4 Abdulrauf SI, Malik GM, Awad IA: Spontaneous angiographic obliteration of cerebral arteriovenous malformations. *Neurosurgery* 1999;44:280–287; discussion 287–288.
- 5 De Lange SA: A case of spontaneous thrombosis of a cerebral arteriovenous aneurysm (in Dutch). *Ned Tijdschr Geneesk* 1955;99:944–946.
- 6 Kushner J, Alexander E Jr: Partial spontaneous regressive arteriovenous malformation; case report with angiographic evidence. *J Neurosurg* 1970;32:360–366.
- 7 Conforti P: Spontaneous disappearance of cerebral arteriovenous angioma. Case report. *J Neurosurg* 1971;34:432–434.
- 8 Eisenman JI, Alekoumbides A, Pribram H: Spontaneous thrombosis of vascular malformations of the brain. *Acta Radiol Diagn* 1972;13:77–85.
- 9 Levine J, Misko JC, Seres JL, Snodgrass RG: Spontaneous angiographic disappearance of a cerebral arteriovenous malformation. Third reported case. *Arch Neurol* 1973;28:195–196.
- 10 Heeres JG, Hekster RE, Thomeer RA: Spontaneous thrombosis of arteriovenous malformation in cerebral vessels, 10 years after manifestation of lesion (in Dutch). *Ned Tijdschr Geneesk* 1976;120:57–61.
- 11 Sasaki U, Itagaki T, Shimizu H, Takahashi M: Almost complete regression of cerebral arteriovenous malformation – report of a case (author's transl) (in Japanese). *No Shinkei Geka* 1976;4:175–181.
- 12 Miyazaki M, Shima T, Yokoyama N, Kuwabara S, Kuwabara S, Sasaki U, et al: Spontaneous, and postirradiation complete regression of arteriovenous malformations (AVM) of the brain proved by angiography (author's transl) (in Japanese). *No Shinkei Geka* 1978;6:195–203.
- 13 Sartor K: Spontaneous closure of cerebral arteriovenous malformation demonstrated by angiography and computed tomography. *Neuroradiology* 1978;15:95–98.
- 14 Nukui H, Miyagi O, Tamada J, Mitsuka S, Kawafuchi J: Long-term follow-up study by cerebral angiography in cases with arteriovenous malformation of the brain. With special reference to spontaneous disappearance of arteriovenous malformation in cerebral angiography (author's transl) (in Japanese). *Neurol Med Chir (Tokyo)* 1982;22:125–132.
- 15 Omojola MF, Fox AJ, Vinuela FV, Drake CG: Spontaneous regression of intracranial arteriovenous malformations. Report of three cases. *J Neurosurg* 1982;57:818–822.
- 16 Wakai S, Chen CH, Wu KY, Chiu CW: Spontaneous regression of a cerebral arteriovenous malformation. Report of a case and review of the literature. *Arch Neurol* 1983;40:377–380.
- 17 Pasqualin A, Vivenza C, Rosta L, Scienza R, Da Pian R, Colangeli M: Spontaneous disappearance of intracranial arterio-venous malformations. *Acta Neurochir (Wien)* 1985;76:50–57.
- 18 Takano S, Nose T, Maki Y, Shinohara A, Kukita C: Spontaneous occlusion of a cerebral arteriovenous malformation – report of a case (in Japanese). *No Shinkei Geka* 1987;15:991–996.
- 19 Gibb PA, Gullan RW, Sandhu N: Spontaneous angiographic disappearance of an intracranial arteriovenous malformation. *Br J Neurosurg* 1988;2:529–533.
- 20 Minakawa T, Tanaka R, Koike T, Takeuchi S, Sasaki O: Angiographic follow-up study of cerebral arteriovenous malformations with reference to their enlargement and regression. *Neurosurgery* 1989;24:68–74.
- 21 Salpietro FM, Cipri S, Tomasello F, Conforti P: Late onset of a large cavernous aneurysm after spontaneous disappearance of cerebral arteriovenous malformation. Case report. *J Neurosurg Sci* 1989;33:211–214.
- 22 Barker CS, Anslow PL: Spontaneous thrombosis of a cerebral arteriovenous malformation. *Clin Radiol* 1990;42:130–132.
- 23 Ezura M, Kagawa S: Spontaneous disappearance of a huge cerebral arteriovenous malformation: case report. *Neurosurgery* 1992;30:595–599.
- 24 Mizutani T, Tanaka H, Aruga T: Total recanalization of a spontaneously thrombosed arteriovenous malformation. Case report. *J Neurosurg* 1995;82:506–508.
- 25 Patel MC, Hodgson TJ, Kemeny AA, Forster DM: Spontaneous obliteration of pial arteriovenous malformations: a review of 27 cases. *AJNR Am J Neuroradiol* 2001;22:531–536.
- 26 Lee SK, Vilela P, Willinsky R, TerBrugge KG: Spontaneous regression of cerebral arteriovenous malformations: clinical and angiographic analysis with review of the literature. *Neuroradiology* 2002;44:11–16.

- 27 Cloft HJ: Spontaneous regression of cerebral arteriovenous malformation in hereditary hemorrhagic telangiectasia. *AJNR Am J Neuroradiol* 2002;23:1049–1050.
- 28 Panciani PP, Fontanella M, Carlino C, Bergui M, Ducati A: Progressive spontaneous occlusion of a cerebellar AVM: pathogenetic hypothesis and review of literature. *Clin Neurol Neurosurg* 2008;110:502–510.
- 29 Gross BA, Du R: Natural history of cerebral arteriovenous malformations: a meta-analysis. *J Neurosurg* 2013;118:437–443.
- 30 Ondra SL, Troupp H, George ED, Schwab K: The natural history of symptomatic arteriovenous malformations of the brain: a 24-year follow-up assessment. *J Neurosurg* 1990;73:387–391.
- 31 Yamada S, Takagi Y, Nozaki K, Kikuta K, Hashimoto N: Risk factors for subsequent hemorrhage in patients with cerebral arteriovenous malformations. *J Neurosurg* 2007;107:965–972.
- 32 Lv X, Wu Z, Jiang C, Yang X, Li Y, Sun Y, et al: Angioarchitectural characteristics of brain arteriovenous malformations with and without hemorrhage. *World Neurosurg* 2011;76:95–99.
- 33 Mabe H, Furuse M: Spontaneous disappearance of a cerebral arteriovenous malformation in infancy. Case report. *J Neurosurg* 1977;46:811–815.
- 34 Lidegaard O, Kreiner S: Cerebral thrombosis and oral contraceptives. A case-control study. *Contraception* 1998;57:303–314.
- 35 Stapf C, Mast H, Sciacca RR, Choi JH, Khaw AV, Connolly ES, et al: Predictors of hemorrhage in patients with untreated brain arteriovenous malformation. *Neurology* 2006;66:1350–1355.