



Intraoperative Rupture During Surgical Resection of Arteriovenous Malformations

Ramón Torné Torné MD; Ana Rodriguez-Hernandez MD; Michael T. Lawton MD

University of California, San Francisco

Department of Neurological Surgery



Introduction

The most feared event during AVM surgery is AVM intraoperative rupture. The bleeding is torrential, more difficult to control than an aneurysm rupture, and significantly impacts the rest of the resection. Our objective is to analyze factors leading to such event and the tenets to avoid it and successfully deal with it.

Methods

During a 15 year period 600 brain AVMs were microsurgically treated by the senior author and prospectively collected in the cerebrovascular service database. 32 patients (5.3%) had an intraoperative rupture. AVM characteristics, operative strategy and outcomes were analyzed in these patients. Causes of AVM rupture were categorized into: 1) rupture of feeding arteries; 2) premature venous occlusion; and 3) nidus penetration.

Results

Out of 32 patients with an intraoperative rupture, 14 (44%) were Spetzler-Martin grade III and 23 (72%) had a supratentorial AVM. Most intraoperative bleeding events were due to the presence of small, friable, uncoagulable vessels (12 patients, 38%); nidus penetration (7 patients, 22%) or premature occlusion of the draining vein (5 patients, 16%). Age and AVM location were not related with the likelihood of an intraprocedural bleed. Two patients died from complications directly related with the intraoperative event. Sixteen out of the 32 intraoperative ruptures (50%) happened during the first 5 years of the senior author's experience.

Conclusions

Uncontrolled bleeding from a brain AVM is the one thing above all others that unnerves surgeons in the operating room and tests their skills. Intraoperative bleeds are associated with intrinsic AVM characteristics (small friable uncoagulable vessels) but also with technical mistakes like underestimated nidus border or unintentional occlusion of venous drainage . Surgeon's experience translates into a lower likelihood of intraoperative rupture of the AVM. The learning curve in AVM surgery diminishes errors in judgment and technique closely related to the intraoperative rupture.

Age	Gender	S-M Grade	AVM Location	PREOPERATIVE TREATMENT		INTRAOPERATIVE RUPTURE		
				radiosurgery	Embolization	Deep Perforators	Vein rupture	Nidus disruption
41	F	4	Parietal	Yes	No	No	No	No
25	F	3	Frontal	No	No	No	No	No
67	M	3	Cerebellar	No	No	No	Yes	No
40	M	1	Frontal	No	No	No	Yes	No
15	M	4	Occipital	No	Yes	No	Yes	No
33	M	4	Temporal	No	Yes	No	No	No
63	M	3	Cerebellar	No	No	Yes	No	Yes
46	M	3	Occipital	No	Yes	No	No	No
46	F	2	Occipital	No	No	No	No	No
34	M	4	Cerebellar	No	Yes	No	Yes	No
68	F	2	Deep central	No	No	Yes	No	No
31	F	2	Frontal	No	Yes	No	No	No
75	M	3	Brainstem	No	No	No	No	No
11	M	3	Cerebellar	No	No	Yes	No	No
46	M	3	Cerebellar	No	Yes	Yes	No	No
37	F	5	Parietal	No	No	Yes	No	No
69	M	3	Parietal	No	No	No	Yes	Yes
41	M	3	Parietal	No	No	No	No	No
40	F	3	Frontal	Yes	No	No	No	Yes
23	M	4	Frontal	No	No	Yes	No	No
31	F	3	Temporal	No	No	Yes	No	Yes
26	M	5	Occipital	No	Yes	No	No	No
46	F	2	Temporal	No	No	Yes	No	Yes
37	M	1	Temporal	No	No	No	No	No
45	M	3	Temporal	No	Yes	Yes	No	No
41	M	4	Parietal	No	No	Yes	No	Yes
48	F	4	Frontal	No	Yes	No	No	No
61	M	2	Temporal	No	No	Yes	No	No
65	M	3	Cerebellar	No	No	Yes	No	No
20	M	4	Temporal	No	Yes	No	No	No
90	F	1	Temporal	No	No	No	No	No
36	M	3	Parietal	No	Yes	No	No	No

REFERENCES

- 1.Laakso A, Hernesniemi J. Arteriovenous Malformations: Epidemiology and Clinical Presentation. *Neurosurgery Clinics of NA*. Elsevier Inc; 2012 Jan 1;23(1):1–6.
- 2.Lawton MT, Kim H, McCulloch CE, Mikhak B, Young WL. A supplementary grading scale for selecting patients with brain arteriovenous malformations for surgery. *Neurosurgery*. 2010 Apr;66(4):702–13–discussion713.
- 3.Mast H, Young WL, Koennecke HC, Sciacca RR, Osipov A, Pile-Spellman J, et al. Risk of spontaneous haemorrhage after diagnosis of cerebral arteriovenous malformation. *Lancet*. 1997 Oct 11;350(9084):1065–8.
- 4.Guo Y, Saunders T, Su H, Kim H, Akkoc D, Saloner DA, et al. Silent Intralesional Microhemorrhage as a Risk Factor for Brain Arteriovenous Malformation Rupture. *Stroke*. 2012 Apr 23;43(5):1240–6.
- 5.Morgan MK, Drummond KJ, Grinnell V, Sorby W. Surgery for cerebral arteriovenous malformation: risks related to lenticulostriate arterial supply. *J. Neurosurg*. 1997 May;86(5):801–5.
- 6.Du R, Keyoung HM, Dowd CF, Young WL, Lawton MT. The effects of diffuseness and deep perforating artery supply on outcomes after microsurgical resection of brain arteriovenous malformations. *Neurosurgery*. 2007 Apr;60(4):638–46–discussion646–8.
- 7.Rodríguez-Hernández A, Kim H, Pourmohamad T, Young WL, Lawton MT. Cerebellar Arteriovenous Malformations. *Neurosurgery*. 2012 Dec;71(6):1111–24.
8. Sanchez-Mejia RO, McDermott MW, Tan J, Kim H, Young WL, Lawton MT. Radiosurgery facilitates resection of brain arteriovenous malformations and reduces surgical morbidity. *Neurosurgery*. 2009;64(2):231–238.
9. Lawton MT, Du R, Tran MN, et al. Effect of presenting hemorrhage on outcome after microsurgical resection of brain arteriovenous malformations. *Neurosurgery*. 2005;56(3):485–493