CASE REPORT

Spontaneous thrombosis of a basilar tip aneurysm after ventriculoperitoneal shunting

Raoul Pop,¹ Salvatore Chibarro,² Monica Manisor,¹ Francois Proust,² Remy Beaujeux¹

¹Department of Interventional Neuroradiology, Strasbourg University Hospitals, Strasbourg, France
²Department of Neurosurgery, Strasbourg University Hospitals, Strasbourg, France

Correspondence to

Dr R Pop, Department of Interventional Neuroradiology, Strasbourg University Hospitals, 1 Place de l'Hopital, S/C IRCAD, Strasbourg 67091, France; pop.raoul@gmail.com

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SUMMARY

We present a case of a large unruptured basilar tip aneurysm with concomitant hydrocephalus. Complete thrombosis of the aneurysm was observed after ventriculoperitoneal shunting. Analyzing preoperative and postoperative MRI and DSA images, we identified reduced intracranial pressure and widening of the aneurysm–artery inclination angle as possible factors influencing spontaneous thrombosis. To the best of our knowledge, this is the first report of aneurysm thrombosis occurring after CSF diversion.

BACKGROUND

Spontaneous aneurysm thrombosis is not uncommon in ruptured aneurysms but it is much more rare in unruptured aneurysms. It has been reported in the pediatric population in particular,¹ and for fusiform and dissecting aneurysms.² Evidence in the literature is mostly related to case reports, and thus relatively little is known about the physiopathological mechanisms underlying this phenomenon.

We report a case of spontaneous aneurysm thrombosis after ventriculoperitoneal (VP) shunting in a patient with chronic hydrocephalus. To the best of our knowledge, this is the first report of aneurysm thrombosis following VP shunt.

CASE PRESENTATION

A 62-year-old patient presented with unsteady gait, intermittent incontinence, and multiple falls over the previous 3 months. Initial CT of the brain showed tetra-ventricular hydrocephalus as well as a basilar tip aneurysm. Cerebral DSA confirmed a large (15 mm diameter) basilar tip aneurysm, with no signs of intra-saccular thrombosis (figure 1A, B). MRI of the brain, performed 6 months later, showed partial thrombosis of the aneurysm, with T1 hyperintense thrombus on its posteroinferior wall (figure 1B, C).

Given the patient's clinical worsening, a VP shunt was performed before undertaking any intervention for the aneurysm. Postoperatively, there was immediate clinical improvement.

OUTCOME AND FOLLOW-UP

After 3 and 6 months of follow-up, the patient had no neurological deficits. Control brain MRI and cerebral DSA were performed to plan the endovascular treatment of the aneurysm. Surprisingly, complete spontaneous thrombosis of the aneurysm was found (figure 1E).

DISCUSSION

Spontaneous aneurysm thrombosis has been repeatedly reported for ruptured aneurysms. Little *et al*³ published a series of 100 cases of subarachnoid hemorrhage with normal initial DSA and subsequent demonstration of thrombosed aneurysms in 5 cases (5%).

Several hypotheses have been proposed to explain the underlying mechanism of this phenomenon: vasospasm,⁴ compressive effect from the surrounding hematoma,⁵ induced hypotension during anesthesia, and flow arrest during DSA.⁶

More rarely, spontaneous thrombosis has been documented for unruptured aneurysms. Most reports are in the pediatric population or are cases of giant/fusiform aneurysms.⁷ In non-giant saccular aneurysms, a large volume to neck ratio⁸ and small inclination angle between the aneurysm and the parent artery⁹ have been advocated as factors favoring spontaneous thrombosis.

In our case, complete thrombosis was observed after VP shunting. Comparing images before and after operation, we observed a reduction in the mass effect induced by the dilated ventricles and a clear change in the morphology of the pre-mesencephalic cistern containing the aneurysm. We observed elevation of the floor of the third ventricle and posterior displacement of the brainstem, due to return to normal size of the third and fourth ventricles, respectively. Consequently, the angle between the aneurysm and the basilar trunk changed from 98° to 109°.

Thus we identified two factors that could have contributed to aneurysm thrombosis: reduced intracranial pressure and widening of the aneurysm–artery angle. These factors altered the shape and flow dynamics inside the aneurysm, with a subsequent change in the distribution of wall shear stress (WSS), leading to a change in endothelial signaling pathways favoring thrombosis.

Of note, thrombosis was observed after widening of the aneurysm–artery inclination angle. This finding is not concordant with other reports that indicate small angle as a factor that favors thrombosis.⁹ Intuitively, aneurysms with small inclination angles are less exposed to forces exerted along the main direction of blood flow and more prone to thrombosis because of increased turbulence and reduced flow velocity. This was not observed in our case, where complete thrombosis occurred after widening of the inclination angle, which increased its exposure to direct inflow from the basilar trunk.

Extensive work has been done using computational fluid dynamics to understand the interaction

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Figure 1 (A, B) Initial DSA, left vertebral artery injection, lateral projection (A), and volume rendering reconstruction of rotational angiography (B), demonstrating a 15×8×9 mm basilar tip aneurysm. (C, D) Brain MRI performed 6 months after the initial angiography. Sagittal time of flight angiography–maximum intensity projection reconstruction (C) and sagittal T1 sequence (D), demonstrating spontaneous partial thrombosis of the aneurysm, with a T1 hyperintense recent thrombus observed on the posteroinferior wall of the aneurysm. Significant enlargement of the third and fourth ventricles is noted (tetra-ventricular hydrocephalus), as well as caudal descent of the cerebellar tonsils and brainstem structures in the foramen magnum. (E) Cerebral DSA, 4 months after ventriculoperitoneal shunt surgery (left vertebral artery injection, lateral projection). Near complete thrombosis of the basilar tip aneurysm is observed, with minor residual filling at the neck. (F) Brain MRI, sagittal T1 sequence, 5 months after surgery. Complete resolution of hydrocephalus and normal position of the posterior fossa structures. Of note, in the absence of third and fourth ventricle mass effect, the angle between the aneurysm and the basilar trunk increased to 109°, from 98° on pre-surgical imaging (C, D).

between rupture risk and thrombosis. The published results are controversial,¹⁰ and the underlying mechanisms remain only partially understood. Both high and low WSS have been reported to indicate the area of aneurysm rupture. Low WSS and reduced velocities were associated with thrombosis. Currently, these models can only provide a limited understanding of flow, as mathematical assumptions and the formulas used largely influence the results. Further work is needed to develop models that can better incorporate the complex variables involved.

In conclusion, we have presented a case of spontaneous thrombosis of an unruptured aneurysm following VP shunting for hydrocephalus. Imaging data suggest that reduced intracranial pressure and widening of the aneurysm–artery angle were factors that may have contributed to spontaneous thrombosis.

Learning points

- Ventriculoperitoneal shunting can induce changes in aneurysm shape.
- Changes in aneurysm shape and angle can alter intra-aneurysmal hemodynamics.

Contributors RP: manuscript drafting, image processing, and literature search. SC: manuscript drafting and review, literature search, and surgical procedure. MM, FP, and RB: manuscript review.

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