Review article

Feeding artery aneurysms associated with large meningiomas: case report and review of the literature

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ABSTRACT

Though brain tumors and intracranial aneurysms co-exist, the occurrence of feeding artery aneurysms with meningiomas are unusual. We describe here a large falcine meningioma that was associated with three feeding artery aneurysms of the anterior circulation. These aneurysms can be treated either by pre-operative endovascular therapy or during the meningioma surgery. The management strategy for these patients will depend on the clinical presentation, morphology and localization of these aneurysms with respect to the tumor.

1. Introduction

Co-existence of brain tumors with intracranial aneurysms is rare, first reported by Arieti in 1944 and occurs with an incidence of 0.3–1% [1, 2], though this association is now being increasingly recognized. The tumors that are known to have this association are meningiomas, pituitary adenomas, and malignant gliomas [1, 2, 3, 4, 5]. Of these, meningiomas are more commonly associated with the formation of an intracranial aneurysm [3]. Though coincidental associations are known between these tumors and aneurysm, the true incidence of flow related aneurysms in the presence of a vascular tumor is likely to be very low and not well established.

2. Case presentation

A 55-year-old female patient with no known prior medical problems, presented with one episode of a generalized tonic-clonic seizure. There were no neurological deficits. A magnetic resonance imaging (MRI) revealed a large, highly vascular, extra-axial tumor arising from the anterior part of the falk cerebri. The superior sagittal sinus was patent, and the differential diagnosis considered was meningioma, hemangiopericytoma and solitary fibrous dysplasia (Figure 1 A,B,C). Despite the presence of a large tumor, there was dilated superficial subarachnoid spaces possibly due to frontal lobe atrophy. On magnetic resonance angiography (MRA), three feeding artery aneurysms were detected in relation to the left pericallosal artery (5 × 4 mm; dysplastic), the left anterior communicating artery (4 × 5 mm saccular) and the right frontopolar artery (5 × 5 mm fusiform) (Figure 1F). In view of the large tumor size, we performed a pre-operative embolization of all three aneurysms (Figure 1 D,E). The tumor was resected through an interhemispheric approach, without any complications. The pathological report showed a meningothelial meningioma OMS grade I. She had a normal neurological examination at discharge from hospital. The neuropsychological examination also was normal. At the follow up visit at three months, she had no neurological symptoms or deficits. The angio MRI did not show any residual aneurysms and demonstrated the remodeling of the dysplastic feeding arteries (Figure 1 G,H).

Informed consent was obtained from the individual participant included in the study.

3. Discussion

The co-existence of intracranial aneurysms and brain tumors are reported to be as low as 0.3% in a series of 23,876 brain tumor patients [4]. Recent advances and availability of imaging techniques has led to an increase in detection of intracranial aneurysms of up to 5% in patients

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diagnosed with brain tumors [6]. However, the association of aneurysms and meningiomas seems to be higher [5, 6, 7]. The exact pathologic mechanism underlying the coexistence of these two pathologies remains unclear. Their formation is postulated to be the result of a complex interaction of flow-related factors, hormonal influence and genetic predisposition. Therefore, several mechanisms of aneurysm formation associated with meningiomas have been proposed [2]. Tumor volume appears to have an effect on the formation of intracranial aneurysms. Increase of blood pressure proportionally with intracranial pressure in order to maintain a constant cerebral perfusion pressure, may lead to an increase of hemodynamic stress around growing meningiomas. Hemodynamic stress induces remodeling and degeneration of internal elastic lamina [7].

Moreover, an increase in directional blood flow in response to angiogenic factors to meet blood supply of highly vascular meningiomas might ensue in abnormal stress on major feeding vessels and is suggested as another possible source of hemodynamic stress [4, 7, 8]. These hypotheses can be supported by the report of Tachikawa et al on an anterior ethmoidal artery aneurysm, associated with an olfactory groove meningioma, in a 51 year old male [8]. Following resection of tumor, a postoperative angiography demonstrated the complete disappearance of the aneurysm.

| Author/Year | Age/Sex | Meningioma Location | Aneurysm Location | Treatment | Outcome |
|-------------|---------|---------------------|------------------|-----------|---------|
| Arseni 1973 [14] | 37/M | Olfactory groove | AcomA | No pre-op embolisation | Patient alive |
| Kandel 1986 [9] | 7/F | Left fronto-temporale | Left MCA | Tumor and aneurysm resection | Patient asymptomatic |
| O’Neill 1995 [20] | 82/F | Convexity meningioma | Middle meningeal artery | Pre-operative embolization and tumor resection | NA |
| Tancioni 1998 [22] | 48/F | Left fronto-temporal | Left MCA | Pre-operative embolization and tumor resection | Improvement of preoperative symptoms |
| Donec 1998 [11] | 50/M | Tuberculum sellae | Calcified AComA | No pre-op embolisation | Patient was discharge home with improved visual acuity |
| Ongino 1999 [21] | 70/F | Tuberculum sellae | Ruptured AComA | Aneurysm clipping and tumor resection | Patient was discharge home |
| Lama 2000 [18] | 69/F | Right pterional | Right middle meningeal artery | Pre-operative embolization and tumor resection | NA |
| Tachikawa 2002 [8] | 51/F | Olfactory groove | Anterior ethmoidal | No pre op embolization | Spontaneous resolution of aneurysm |
| Javadpour 2004 [17] | 61/F | Suprasellar | AComA | Pre-operative embolization and tumor resection | Patient was discharge home |
| Fischer 2008 [3] | 44/M | Left Sphenoid wing | ICA | Preoperative embolization, clipping and tumor resection | CNIII palsy |
| Maekawa 2009 [19] | 72/F | Left frontal convexity | Left middle meningeal artery | Pre-operative aneurysm embolization and tumor resection | Satisfactory postoperative course |
| Dumitrescu 2011 [15] | 64/M | Tuberculum sellae | AComA | Aneurysm clipping and tumor resection | Complete anosmia |
| Zhong 2013 [6] | 49/M | Falx/planum | ACA | Aneurysm clipping and tumor resection | Patient alive |
In 1998, Kandel et al introduced another hypothesis in a case report of a saccular aneurysm of the middle cerebral artery that was enclosed in a frontotemporal meningioma [9]. Microscopic examination demonstrated that the tumor was attached to the arterial adventitia, and therefore the authors ascribed the development of the aneurysm to the damage to the arterial wall. However, this hypothesis cannot explain the formation of aneurysms not directly localized near tumors.

An endocrinological-mediated mechanism has been proposed in some papers, which presented a possible influence of estrogens in the development of both meningiomas and aneurysms [10, 11]. Other studies focalized on the genetic aspects have shown that some gene mutations were common for both pathologies, such as 1p36.2-p34, 11q13 and 17p13.1 [12, 13].

Based on the hypothesis that aneurysm formation is, at least partially, due to hemodynamic stress on the feeding arteries of a meningioma, we performed a review of the English literature including only cases of aneurysms localized selectively on a feeding artery of a meningioma (Table 1). A total of 13 cases were identified [3, 6, 9, 14, 15, 16, 17, 18, 19, 20, 21, 22]. Eight (61.5%) patients were females. The most common localization was the anterior circulation (61.5%), particularly the anterior communicating artery (38.5%). Three cases of aneurysm on the external carotid artery circulation (middle meningeal artery) were also documented. Only one of these cases presented with a subarachnoid hemorrhage (SAH) related to the rupture of a feeding artery aneurysm [21].

In patients with coexisting intracerebral aneurysms and meningiomas, the lesion that is symptomatic should be treated at first [5]. When subarachnoid hemorrhage is the primary presentation, the aneurysm should be treated before tumor surgery. However, in cases of an unruptured aneurysm, the options of treatment either by pre-tumor excision embolization or by direct clipping during tumor surgery, both exist [4, 6, 7].

In the review of the literature of these 13 cases, 6 patients were treated by pre-operative embolization of the aneurysm, followed by surgical resection of the meningioma (Table 1). Concomitant treatment treated by pre-operative embolization of the aneurysm, followed by pre-operative treatment of the aneurysms allowed a safe dissection of the tumor and the aneurysm was achieved in 4 patients. Three patients did not have any treatment for the aneurysms and follow up imaging showed resolution or stability of the aneurysms. All authors have documented. Only one of these cases presented with a subarachnoid hemorrhage (SAH) related to the rupture of a feeding artery aneurysm [21].

Based on the hypothesis that aneurysm formation is, at least partially, due to hemodynamic stress on the feeding arteries of a meningioma, which had behaved like an arteriovenous shunt. This had also interestingly induced a lobar atrophy akin to the “steal syndrome” seen in arteriovenous malformations. The fact that the elimination of the meningioma allowed for reversal of the vasculopathy in the feeding arteries, lends further credence to the etiopathogenesis of the vascular malformations in this patient.

4. Conclusion

The coexistence of large hypervascular meningiomas and feeding arteries aneurysms though rare, needs to be considered in the pre-operative radiological evaluation of these patients. The mechanism of formation of such aneurysms is likely to be related to the hemodynamic stresses on these feeding arteries caused by the increased blood flow to the meningioma. The treatment strategy should be tailored depending on the clinical presentation and anatomical relation of the aneurysms to the tumor.

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Additional information

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