Aneurisma em Trifurcação de Artéria Cerebral Média: relato de caso e revisão da literatura

Middle Cerebral Artery Trifurcation Aneurysm: a case report and literature review

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RESUMO
A artéria cerebral média tem anatomia microcirúrgica e complexidade únicas. Uma verdadeira trifurcação da artéria cerebral média é rara, ocorrendo em apenas 12% dos hemisférios cerebrais. Apresentamos aqui uma revisão da literatura e um caso incomum de aneurisma de trifurcação da artéria cerebral média. Este aneurisma foi encontrado incidentalmente em uma tomografia computadorizada de seguimento em paciente assintomático para neoplasia de cabeça e pescoço. A angiografia cerebral digital diagnosticou um aneurisma sacular localizado no ramo inferior da trifurcação da artéria cerebral média direita (transição M1-M2). O paciente foi submetido a craniotomia pterional clássica com clipagem microcirúrgica bem-sucedida. No pós-operatório, o paciente estava clínica e neurologicamente sem complicações. Os aneurismas representam uma condição rara, respondendo por aproximadamente 5 a 10% da prevalência na população em geral e há uma prevalência ligeiramente maior quando avaliado idade e sexo. Então, pode-se dizer que os aneurismas de trifurcação da artéria cerebral média descritos nesse estudo são uma condição ainda mais rara, decorrentes de um distúrbio patológico do vaso que leva à uma hidrodinâmica e ao desenvolvimento do aneurisma.

Palavras-chave: Trifurcação de artéria cerebral média; Aneurisma; Clipagem

ABSTRACT
The middle cerebral artery has unique microsurgical anatomy and complexity. A true middle cerebral artery trifurcation is rare, occurring in only 12% of cerebral hemispheres. Here we present a literature review and an unusual case of middle cerebral artery trifurcation aneurysm. This aneurysm was found incidentally in an asymptomatic patient during serial screening CT for head and neck neoplasm. Digital cerebral angiography diagnosed a saccular aneurysm located at the inferior branch of the right middle cerebral artery trifurcation (M1-M2 transition). He underwent a successful classic pterional craniotomy for microsurgical clipping. Post-operatively, the patient was clinically and neurologically intact. Aneurysms represent a rare condition, accounting for approximately 5 to 10% of prevalence in the general population and have a slightly higher prevalence when adjusted for age and sex. Then, it is depictable that a middle cerebral artery trifurcation aneurysm is an even rarer condition, teaching us more about the hydrodynamic physics of pathological vessel distress in aneurysm development.

Keywords: Middle cerebral artery trifurcation; Aneurysm; Clipping

Received Aug 16, 2021
Accepted Aug 24, 2021
INTRODUCTION

The middle cerebral artery (MCA) is one of the main branches of the internal carotid artery (ICA). The MCA has a larger ramifications when compared to the anterior and posterior cerebral arteries, being responsible for the irrigation of most of the brain area, providing blood for its cortical and deeper parts.

Its anatomy is vastly studied because it is apparent in most operations in the supratentorial areas, parasagittal region, skull base and also because of its complex pathways and constitution, with wide anatomical variations mainly to its branching pattern, in which 78% corresponds to bifurcation, 12% trifurcation and 10% give rise to multiple trunks.

Its variations lead to different irrigation areas as well as different clinical manifestations and may be related to the predisposition to neurovascular diseases. Its perfusion area extends to most of the brain and is closely related to its development, both of the frontal, temporal and parietal lobes. Variations in the cerebral arterial circle (CAC), where the MCA is located, are frequent.

With the diffusion of the use of magnetic resonance imaging (MRI) and computed tomography (CT) for diagnosis, the prevalence of intracranial saccular aneurysms is increasing. Aneurysms are acquired lesions and characterized by an abnormal and persistent dilation of an artery, which can generate saccular, fusiform, or infectious forms.

They affect about 5 to 10% of the world’s population. Most of these dilations remain asymptomatic and immutable throughout the patient’s life, but they may also have complications. The most severe is rupture, which is associated with high mortality due to intracranial hemorrhages. In this scenario, aneurysms are responsible for about 80 to 85% of nontraumatic subarachnoid hemorrhages nowadays.

In this paper, we will report a case of a trifurcated middle cerebral artery aneurysm and a literature review. The presented anatomical variation is not the most recurrent pattern, added to the fact that the occurrence of aneurysm in this division makes the case even less incident.

CASE PRESENTATION

Black man, 52 years old, former-smoker for 15 years. He is used to undergo oncologic follow-up due to oropharyngeal carcinoma, diagnosed in early 2020. The patient underwent chemotherapy and radiotherapy until February 2021 with complete remission of the disease. During his control cranial tomography, a saccular aneurysm was evidenced in the middle cerebral artery, at its bifurcation, measuring about 4 mm with 2 mm neck measure. Due to this image, the patient was forwarded to neurosurgery evaluation in March 2021. In consultation with neurosurgery, no neurological symptoms were detected and he was offered a hospitalization for further evaluation and treatment of the aneurysm.

Cerebral angiography showed a saccular aneurysm in the trifurcation of the right middle cerebral artery in its lower division measuring 3.8 x 3.7 x 3.6 mm with 2.2 lateral orientated neck.

Figure 1. Lateral view of right internal carotid artery and its branches. Aneurysm in the right middle cerebral artery (black arrow).
The surgery was done with a pterional craniotomy, opening the Sylvian fissure by microsurgical technique and M1 middle cerebral artery branch was identified. After cerebrospinal fluid drainage, we could also see the second division of the middle cerebral artery with the trifurcation, and the aneurysm was turned back and up, facing the temporal lobe and the insula (Figures 1, 2 and 3). Since the neck could be seen, it was possible to do a microsurgical clipping, putting one semicurval clip, and a second one to close the aneurysm (Figures 4 and 5). Then, the patient was submitted to an indocyanine green contrast angiogram and the aneurysm was completely occluded (Figure 6) and, after that, the craniotomy was closed. The patient woke up after the surgery very well and did not evolve with sequelae (Figure 7). He remained in neurointensive observation for one day and was discharged three days after surgery.
After searching PubMed database about aneurysms in the MCA trifurcation, 58 articles were found. After analyzing the title and abstract, 34 were eliminated, leaving 24 studies that were included in this review. Table 1 shows the data for each of them. Exclusion criteria were articles about aneurysms in other arteries, cases not completely described and those with only diagnostic imaging procedures and exams. The articles included are mainly observational and descriptive published from 1977 to 2020. These 24 studies reported a total of 84 patients.

**Figure 6.** Intraoperative intravenous indocyanine green (ICG) contrast showing vascular perfusion in the tree branches right-after aneurysm clipping.

**Figure 7.** Outcome after 15 days of clipping, with no disabilities.

**DISCUSSION**

The anterior circulation, which includes the anterior cerebral artery (ACA) and anterior communicating artery (ACoA), is the most common location of an intracranial aneurysm (40%). These are commonly associated with anatomical variations, which are considered as risk factors to aneurysm development. The MCA aneurysms are the most common cause of non-traumatic subarachnoid hemorrhage, and the M1-2 bifurcation or primary trifurcation is the most frequently affected areas.

The MCA originates in the medial end of the Sylvian fissure. The structures around the MCA are the optic chiasm laterally, the division of the olfactory tract into the medial and lateral olfactory striae posteriorly, and the anterior perforated substance superiorly. It originates perforating branches called lenticulostrate arteries during its course below the anterior perforated substance. After its division within the Sylvian fissure, it turns posterosuperiorly, creating a genu and reaching the surface of the insula. Once on this surface, the artery goes through the frontal, temporal and parietal operculum, supplying most of the lateral surface and part of the basal region of the cerebral hemisphere.

MCA is divided into four segments called M1 (sphenoid), M2 (insular), M3 (opercular), and M4 (cortical). The M1 segment originates at the internal carotid bifurcation and extends to the genu, where there is a 90 degrees turn. This segment is subdivided into pre-bifurcation and post-bifurcation, and the bifurcation itself is located proximal to the genu in approximately 90% of the hemispheres. The M2 segment begins at the genu, where the MCA trunk passes over the insula’s limen and ends in the circular groove of the insula. The M3 begins in the circular sulcus of the insula and ends in the surface of the Sylvian fissure. And finally, from the fissure
to the cortical surface of the cerebral hemisphere, there is the M4 segment of the MCA.

The MCA can be classified into four different types: bifurcation (78%), trifurcation (12%), division in multiple trunks (10%), and MCA without trunks or unique principal trunk. Studies described that there may be a bifurcation distal to the main one of the upper or lower trunk of the MCA, giving rise to an intermediate trunk. When this trunk arises near the main bifurcation, there is the formation of a pseudotrifurcation and, when an intermediate trunk arises from the upper and lower trunks near the main bifurcation, a pseudoquadrifurcation is originated.

These main trunk variations may have clinical meanings associated with pathological situations, such as occlusion in an area with a single trunk producing greater ischemia than this same event in trifurcation or quadrifurcation areas. These differences should be analyzed by the surgeon during the dissection of the Sylvian fissure, once the clipping may close the main trunk. These cases are more susceptible to cause greater complications.

The exact pathophysiology of aneurysms is not fully elucidated. However, since they occur mostly in arterial branching sites, shear stress is an important risk factor for its appearance. Therefore, the shear tension, by the increased blood turbulence in this area, performs a pressure in the artery wall, culminating in its dilation. Also, according to Cunha and Cunha (2018), the smaller extension of the M1 segment and, therefore, the higher blood pressure at the arterial bifurcation seems to be closely related to the emergence of these pathological bulges.

The formation of aneurysms is related mainly to atheromatosis, as well as to other factors such as advanced age, sex, alcoholism, smoking, inherited connective tissue diseases, hypertension, and intracranial vessel development disorders. Drugs with high doses of estrogen, cocaine, and low body mass index also appear to have some relationship with a higher risk of subarachnoid hemorrhage. In our review, the age of patients ranged between 9 and 80 years, with 47.5 as mean age. Aneurysms may occur alone or together with multiple aneurysms in the same finding and are more likely to appear in female gender when compared to their incidence in males (3:1). In addition to the higher incidence in the female gender, aneurysms bleed almost 1.3 times more in women when compared with men, and more than 2 times in black individuals when compared to the white ones. The results of our review were in accordance with literature data, once 54.7% (46/84) of the patients were women and 44% (37/84) men. Only one article did not specify the patient’s gender.

Family history is also a major unchanging risk factor for the occurrence of aneurysms. In our review, we found a case of a patient who had 5 siblings with cases of subarachnoid hemorrhage resulting from ruptured aneurysms, highlighting the importance of valuing the patients’ family history.

The main red flags for the presence of a brain aneurysm are pain behind the eye, cranial nerve paralysis, headache, and neck pain secondary to blood leakage in the aneurysm, called “sentinel headache”. Accordingly, the most cited symptoms in our review were headache and motor deficits.

The clinical presentation of a bifurcated aneurysm may be confused with an ischemic stroke or an internal infarction caused by distortion or compression of perforating arteries in the branches in bifurcation. When asymptomatic, aneurysms are frequently found when investigating other diseases or during image control exams. By the time they grew, they became symptomatic, expanding and compressing adjacent areas.

The cranial arteries most prone to the appearance of aneurysms are the anterior cerebral artery, anterior communicating artery, middle cerebral artery, and internal carotid artery, mainly in their bifurcation or communication fields. About one-fifth of all intracranial aneurysms are located in the middle cerebral artery, mainly at the level of its bifurcation, and are one of the most prone to its rupture. Following this, our review demonstrated that 77.4% (65/84) of the aneurysms in the trifurcation of the middle cerebral artery were ruptured. 14.3% (12/84) were not ruptured and 8.3% (7/84) did not mention or the authors didn't know it for sure.
On average, 12% of the middle cerebral arteries present an anatomical variation represented by their trifurcation. This region is more likely to have cerebral embolism and, consequently, ischemia of the affected regions. Thus, although rare, aneurysms located in trifurcations of middle cerebral arteries may present devastating consequences in patients affected by this event.

The treatment of the non-ruptured aneurysm in trifurcation represents an important focus of current medical research and its pattern of bi/trifurcation influences the surgical approach, complication rates, and prevalence. With the evolution of diagnostic approaches, the large utilization of CT angiography and 3D CT is very helpful in both early diagnosis and surgical planning. According to our review, the diagnosis and location of the aneurysm were described mostly through tomography and arteriography. In one case report, the presence of an aneurysm in the trifurcation was correctly confirmed only during surgery, as it had been interpreted as a bifurcation by imaging. Besides that, our case also had disagreement in the MCA classification between the CT scan and angiography, in which only the angiography showed the real anatomy. This demonstrates that the visualization and interpretation of aneurysms by different imaging is not always completely accurate and sometimes only in the intraoperative period it is elucidated.

In an attempt to standardize a better approach for ruptured aneurysms, the BRAT study found no major differences between clipping aneurysms and their coil embolization. However, there was a better outcome in cases of small aneurysms and those presented in anterior circulation with the clipping technique when compared to its embolization.

Regarding the surgical techniques in our review, 73.8% (62/84) had aneurysms resolved by exclusively endovascular procedures, 15.5% (13/84) only by clipping, 4.8% (4/84) by mixed procedures, 1.2% (1/84) by resection, 2.4% (2/84) underwent conservative treatment and in 2.4% (2/84) the original article did not specify it.

About the surgical outcome, 11 of the 13 (84.6%) patients who underwent aneurysm clipping were successful, not evolving with any complications after the procedure. One of them, despite the surgery being a success, died due to a vasospasm resulting from subarachnoid hemorrhage. Two were not successful, since one of the patients evolved with a cerebrospinal fluid leak and meningitis and the other with hoarseness.

Accordingly, 61 of 62 (98.4%) patients that underwent endovascular procedures were successful in the surgery, with no complications. Exception for one case, in which the surgery was successful, but the patient evolved with a mass around the aneurysm, probably due to the patient's underlying disease (neurofibromatosis).

Considering only the ruptured aneurysms, 7 were treated by clipping and 54 by endovascular techniques. All of them had satisfactory results after the surgical procedure. Thus, our review is in agreement with the conclusion of the BRAT study, as both techniques had high success rates in these cases.

Finally, although the clipping technique is a good operative maneuver, in this case, cautiousness is needed during the vascular repair to avoid blood flow interruption for the perforating branches resulting in neurological deficits.

We emphasize the unusualness of the reported case, once it presents an aneurysm in a trifurcation of the middle cerebral artery that is poorly described in the literature with a clipping technique usually recommended for ruptured aneurysms. Thus, this condition deserves further discussion in the future to properly evaluate these techniques for resolving similar cases and decrease the morbidity and mortality of these patients.
Table 1. Review of the literature of middle cerebral artery trifurcation aneurysm.

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Study design / Number of patients</th>
<th>Gender / Age</th>
<th>Symptoms</th>
<th>Diagnosis method</th>
<th>Aneurysm status</th>
<th>Surgical Technique</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benndorf et al.¹⁴</td>
<td>2002</td>
<td>Case reports / 1</td>
<td>F / 41</td>
<td>Aphasia and numbness in her right hand that lasted for about 5 minutes</td>
<td>AGG: saccular aneurysm of the IMCA trifurcation (14-15mm)</td>
<td>Unruptured</td>
<td>Endovascular</td>
<td>No complications due to surgery</td>
</tr>
<tr>
<td>Catapano et al.¹⁵</td>
<td>2020</td>
<td>Surgical video with case report / 1</td>
<td>F / 60</td>
<td>Headache</td>
<td>AGG: MCA trifurcation aneurysm</td>
<td>*</td>
<td>Clipping and bypass</td>
<td>No complications due to surgery</td>
</tr>
<tr>
<td>Chen et al.¹⁶</td>
<td>2017</td>
<td>* / 57</td>
<td>26 M; 31 F / 34-75</td>
<td>Hunt-Hess grades for ruptured aneurysms: 7 Grade I, 32 Grade II, 11 Grade III</td>
<td>AGG: MCA trifurcation aneurysm</td>
<td>50 ruptured 7 unruptured</td>
<td>Endovascular (coil)</td>
<td>No complications due to surgery</td>
</tr>
<tr>
<td>Diaz et al.¹⁷</td>
<td>1985</td>
<td>Case reports / 4</td>
<td>F / 47</td>
<td>Right frontal headaches</td>
<td>AGG: giant rMCA trifurcation aneurysm</td>
<td>*</td>
<td>Clipping</td>
<td>No complications due to surgery</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>M / 48</td>
<td>Left parietal headaches</td>
<td>AGG: giant lMCA trifurcation aneurysm</td>
<td>*</td>
<td>CSF leak, meningitis</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>F / 46</td>
<td>Transient left monoparesis</td>
<td>AGG: giant rMCA trifurcation aneurysm</td>
<td>*</td>
<td>No complications due to surgery</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>M / 53</td>
<td>Left hemiparesis</td>
<td>AGG: giant rMCA trifurcation aneurysm</td>
<td>*</td>
<td>No complications due to surgery</td>
<td></td>
</tr>
<tr>
<td>Ellis¹⁸</td>
<td>2011</td>
<td>Case reports / 1</td>
<td>F / 9</td>
<td>Sudden loss of consciousness and left hemiplegia</td>
<td>CT scan: right frontal hemorrhage</td>
<td>Ruptured</td>
<td>Endovascular</td>
<td>No complications due to surgery After 2 months MRI showed irregularly enhancing mass surrounding the MCA trifurcation</td>
</tr>
<tr>
<td>Guo et al.¹⁹</td>
<td>2014</td>
<td>Case reports / 1</td>
<td>F / 49</td>
<td>Hunt-Hess grade II</td>
<td>CT scan, MRI: ruptured aneurysm located at the trifurcation of MCA</td>
<td>Ruptured</td>
<td>Endovascular</td>
<td>No complications due to surgery</td>
</tr>
<tr>
<td>University of South Alabama Headache Center²⁰</td>
<td>2005</td>
<td>Case reports / 1</td>
<td>F / 64</td>
<td>Episodic migrainous headache with associated &quot;dizziness&quot;</td>
<td>MRI: saccular aneurysm involving the rMCA trifurcation and a smaller aneurysm involving the intracranial right ICA in its cavernous portion</td>
<td>Ruptured</td>
<td>Clipping</td>
<td>No complications due to surgery</td>
</tr>
</tbody>
</table>
### Table 1. Review of the literature of middle cerebral artery trifurcation aneurysm. (continued)

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<th>Aneurysm status</th>
<th>Surgical Technique</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortiyama et al.</td>
<td>1992</td>
<td>Case reports / 1</td>
<td>F / 51</td>
<td>Exacerbation of the consciousness disorder</td>
<td>CT scan: SAH and hydrocephalus. AGG: 1 secular aneurysm in the trifurcation of the rMCA, 3 fusiform aneurysms in the rMCA, 2 fusiform aneurysms in the posterior cerebral artery</td>
<td>Ruptured</td>
<td></td>
<td>The patient died 8 weeks after hospitalization</td>
</tr>
<tr>
<td>Ogane et al.</td>
<td>1998</td>
<td>Case reports / 1</td>
<td>F / 64</td>
<td>Mild headache, nausea, vomiting, signs of bilateral deafness, right facial palsy of central type and very slight neck stiffness</td>
<td>CT scan: SAH. AGG: right aneurysm at the MCA trifurcation</td>
<td>Ruptured</td>
<td>Clipping</td>
<td>No complications due to surgery</td>
</tr>
<tr>
<td>Sakaki et al.</td>
<td>1990</td>
<td>Case reports / 1</td>
<td>F / 22</td>
<td>Severe headaches, vomiting, loss of consciousness and right hemiparesis. She had systemic lupus erythematosus established for 4 years</td>
<td>CT scan: important SAH with ventricular dilatation. AGG: 2 fusiform aneurysms of the left ICA and 3 fusiform aneurysms at the trifurcation of IMCA. Autopsy: 2 fusiform aneurysms in the left ICA and 3 fusiform aneurysms in the IMCA, one of which had ruptured</td>
<td>ICA aneurysms: 2 unruptured MCA aneurysms: 2 unruptured and 1 ruptured</td>
<td></td>
<td>She died 15 days after the onset of the SAH</td>
</tr>
<tr>
<td>Selhar et al.</td>
<td>2005</td>
<td>Case reports / 1</td>
<td>F / 49</td>
<td>Headaches, syncope and history of hypertension</td>
<td>AGG: giant rMCA trifurcation fusiform aneurysm</td>
<td>Unruptured</td>
<td></td>
<td>An SVG bypass was placed from the external carotid artery to the M2 segment of the MCA. The aneurysm was emptied of blood and clipped</td>
</tr>
<tr>
<td>Vanninen et al.</td>
<td>1996</td>
<td>Case reports / 1</td>
<td>F / 43</td>
<td>Headache and Grade V (Hunt and Hess)</td>
<td>CT scan: severe SAH and an intracerebral hematoma. AGG: small ruptured IMCA trifurcation aneurysm (7mm), and very small aneurysms (2mm) in one of the branches of the same MCA and in the superior cerebellar artery</td>
<td>Ruptured</td>
<td>Clipping of the 2 MCA aneurysms</td>
<td>No complications due to surgery. Patient’s condition improved to Grade IV (Hunt and Hess)</td>
</tr>
<tr>
<td>Wakamuto et al.</td>
<td>2001</td>
<td>Case reports / 1</td>
<td>F / 71</td>
<td>Dysarthria and right hemiparesis</td>
<td>CT scan: SAH in the left cerebral sulcus AGG: aneurysm arising from the IMCA and rMCA due to septic embolism</td>
<td></td>
<td>Resection</td>
<td>No complications due to surgery</td>
</tr>
</tbody>
</table>
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<th>Study design / Number of patients</th>
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<th>Surgical Technique</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wakui et al.25</td>
<td>1992</td>
<td>Case reports / 1</td>
<td>F / 54</td>
<td>Severe headache with mild stiff neck and nausea 3 months after surgery of aortic valve replacement. During this time she received prednisolone and warfarin</td>
<td>CT scan: SAH in the basal cisterns AGG: aneurysm at the bifurcation of the rMCA (13mm), and a small aneurysm at the right ICA anterior choroidal artery junction</td>
<td>Ruptured</td>
<td>Clipping</td>
<td>No complications due to surgery initially oriented, but condition deteriorated due to diffuse vasospasm and the patient died on the 11th post-SAH day</td>
</tr>
<tr>
<td>Yoshioka et al.26</td>
<td>1990</td>
<td>Case reports / 1</td>
<td>F / 33</td>
<td>*</td>
<td>AGG: 4 intracranial aneurysms – 2 on the ICA, 1 on the trifurcation of the MCA, and 1 on the anterior communicating artery</td>
<td>Ruptured</td>
<td>Clipping</td>
<td>No complications due to surgery</td>
</tr>
<tr>
<td>Bidziński et al.27</td>
<td>1981</td>
<td>Case reports / 1</td>
<td>M / 58</td>
<td>*</td>
<td>AGG: aneurysm at the rMCA trifurcation Blood cultures: positive for alpha hemolytic Streptococcus</td>
<td>Ruptured</td>
<td>Clipping of all four aneurysms</td>
<td>No complications due to surgery</td>
</tr>
<tr>
<td>Bingham28</td>
<td>1977</td>
<td>Case reports / 1</td>
<td>M / 31</td>
<td>Easy fatigability, weight loss, headaches, fever, hemiparesis which progressed to hemiplegia</td>
<td>AGG: aneurysm at the rMCA trifurcation Blood cultures: positive for alpha hemolytic Streptococcus</td>
<td>Ruptured</td>
<td>Clipping</td>
<td>Regained considerable left upper and lower limb function</td>
</tr>
<tr>
<td>Komatsu et al.29</td>
<td>1988</td>
<td>Case reports / 1</td>
<td>M / 41</td>
<td>Severe headache, vomiting and transient consciousness disturbance</td>
<td>CT scan: SAH AGG: aneurysm at the trifurcation of the IMCA</td>
<td>Ruptured</td>
<td>Clipping</td>
<td>No complications due to surgery, but the patient started to bleed and died in the 20th day (mild hemophilia B)</td>
</tr>
<tr>
<td>Maramattom &amp; Wijdicks30</td>
<td>2002</td>
<td>Case reports / 1</td>
<td>M / 80</td>
<td>Thunderclap headache</td>
<td>CT scan: Blood in the left Sylvian fissure AGG: aneurysm at trifurcation of the IMCA (7mm)</td>
<td>Ruptured</td>
<td>Endovascular (coil)</td>
<td>*</td>
</tr>
<tr>
<td>Murayamae et al.31</td>
<td>1985</td>
<td>Case reports / 1</td>
<td>M / 59</td>
<td>Thunderclap headache, conscious impairment and vomiting</td>
<td>AGG: ruptured aneurysm at the junction of the persistent primitive hypoglossal artery and basilar artery on the left side and another aneurysm in the rMCA trifurcation (small and saccular)</td>
<td>Not clear</td>
<td>Clipping</td>
<td>Hoarseness</td>
</tr>
<tr>
<td>Takeda et al.32</td>
<td>1998</td>
<td>Case reports / 1</td>
<td>M / 67</td>
<td>*</td>
<td>Autopsy: fresh SAH and a ruptured fungal aneurysm near the trifurcation of the rMCA. The aneurysm was caused by direct Candida invasion of the arterial wall from the Candida embolus. The source of the Candida was endocarditis</td>
<td>Ruptured</td>
<td>*</td>
<td>Died 4 days after suffering a SAH</td>
</tr>
</tbody>
</table>
Aneurisma em Trifurcação de Artéria Cerebral Média: relato de caso e revisão da literatura

Table 1. Review of the literature of middle cerebral artery trifurcation aneurysm. (continued)

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</tr>
</thead>
<tbody>
<tr>
<td>Weill et al.35</td>
<td>1998</td>
<td>Case reports / 2</td>
<td>M / 20</td>
<td>Headache and vomiting</td>
<td>CT scan, MRI, and AGG: giant</td>
<td>Unruptured</td>
<td>1) Endovascular (1 with balloon and 5 with coils) 2) Surgery for a right STA-MCA bypass</td>
<td>No complications due to surgery</td>
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<td>rMCA trifurcation aneurysm</td>
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<td>CT scan: giant aneurysm of the rMCA</td>
<td>Unruptured</td>
<td>1) Wrapping on the right giant aneurysm 2) Surgery for a right STA-MCA bypass</td>
<td>No complications due to surgery</td>
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<td></td>
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<td>M / 41</td>
<td>Head trauma with brief impairment of consciousness</td>
<td>AGG: 1 giant aneurysm of the mCA trifurcation and 2 small aneurysms of the IMCA trifurcation</td>
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<tr>
<td>Yamasaki et al.36</td>
<td>1977</td>
<td>Case reports / 1</td>
<td>M / 62</td>
<td>*</td>
<td>*</td>
<td>Unruptured</td>
<td>Clipping</td>
<td>No complications due to surgery</td>
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<td>Guo et al.37</td>
<td>2014</td>
<td>* / 1</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>Ruptured</td>
<td>Endovascular (coil)</td>
<td>No complications due to surgery</td>
</tr>
</tbody>
</table>

F: female; M: male; MRI: magnetic resonance imaging; AGG: angiography; CT: computed tomography; MCA: middle cerebral artery; rMCA: right middle cerebral artery; lMCA: left middle cerebral artery; ICA: internal carotid artery; SAH: subarachnoid hemorrhage; IO: intraoperative; STA-MCA: superficial temporal artery-middle cerebral artery; SVG: saphenous vein graft; CSF: cerebrospinal fluid; *: not cited by the original article

REFERENCES

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