Clip reconstruction of a large right MCA bifurcation aneurysm. Case report

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Abstract

We report a case of complex large middle cerebral artery (MCA) bifurcation aneurysm that ruptured during dissection from the very adherent MCA branches but was successfully clipped and the MCA bifurcation reconstructed using 4 Yasargil clips. Through a right pterional craniotomy the sylvian fissure was largely opened as to allow enough workspace for clipping the aneurysm and placing a temporary clip on M1. The patient recovered very well after surgery and was discharged after 1 week with no neurological deficit. Complex MCA bifurcation aneurysms can be safely reconstructed using regular clips, without the need of using fenestrated clips or complex by-pass procedures.

Key words: MCA bifurcation; Yasargil clips; clip reconstruction.

Introduction

The MCA aneurysms represent 20-25 % of all intracranial aneurysms. Given their complex anatomy including broad necks, trifurcated anatomy and the high risk to occlude a small branch whose origin cannot be seen on angiography when detaching the coils these aneurysm are considered unfavorable for endovascular treatment. Because they are easy to reach in the Sylvian fissure and in that region the fissure is large enough to allow complex reconstruction and bypass techniques if necessary the best treatment for these lesions is surgical clipping. Several studies showed the surgical results to be superior to endovascular results. (3, 4) This article reports the reconstruction of MCA branches by applying several parallel clips to a large MCA aneurysm that could not be dissected and ruptured while being dissected from one of the branches. (6, 7, 12)

Case report

A 59 years old right handed woman with multiple associated pathology including basocellular nose carcinoma operated 2 years prior, glaucoma, diabetes mellitus, and psychiatric symptoms including depression and bipolar disorder, presented for intense headache worsened over the last two weeks. The patient had a two years history of intermittent headache. A CT angiography 1 week prior admission indicated the presence
of a right MCA bifurcation aneurysm. The lesion was confirmed on the angiography but the neck was very difficult to describe because of 4 branches of the MCA surrounding the aneurism given the very close. This aspect was probably due to the bifurcation of each of the 2 M2's immediately after emergence from M1. No subarachnoid hemorrhage was visible on CT so it was an incidental discovery. The rotational angio CT in our department was more useful than the angiography because it showed the relation of the aneurism with the MCA branches whereas on angiography the branches superimposed on the contour of the aneurysm and the neck could not be distinguished.

The patient was positioned supine with the head rotated 45° to the left. A right frontotemporal standard craniotomy was performed. After the dural incision the Sylvian fissure was opened from distal to proximal. The M1 was identified with a large bilobulated aneurysm at its bifurcation. Immediately after origin from M1 both M2 bifurcated and all 4 branches engulfing the aneurysm prevented the operator to gain access to the neck. A very adherent branch separated the two lobes of the aneurysm. When attempting to dissect the dome from this branch, given the very thin wall at this level, a punctiform hole was created in the aneurysm but the wall did not tear. A temporary clip was applied on M1 and removed 1 minute later after a definitive curved clip was applied on the hole in the aneurysm and the bleeding stopped.

The aneurysm was next reconstructed using two more curved clips on the bigger (frontal) lobule with care to spare the frontal M2 branch adherent to the dome. Than the temporal lobule was reconstructed with a 4th clip applied between two temporal branches. (Figures 1 and 2). No retractor was needed during surgery, the suction tube was used as a retractor (1). Also the importance of Sylvian fissure opening should be stated. Before closure the arterial pressure was raised to make sure there was no bleeding, and the clipping was controlled with a Doppler probe to make...
sure no MCA branch is occluded and no aneurism remnant was left. The dura was closed and circullary suspended to the fascia, the bone flap fixed in place with separated sutures and the scalp closed.

The patient showed no neurological deficit after the surgery and she was discharged 7 days after surgery. The postoperative angiography showed a good flow in the right MCA peripheral branches and the disappearance of the aneurysm.

**Figure 2** - A. Tight adherent branch dissection; B. rupture of the aneurysm; C. first clip including the rupture site; D. second clip inserted under a frontal branch; E. third clip on the small temporal aneurysm lobule; F. fourth curved clip to include the rest of the aneurysm

**Figure 3** - Graphic depiction of the dissection and clipping starting with freeing the dome from the highly adherent branches on its surface followed by rupture and clip reconstruction
Discussion

Treatment of complex MCA bifurcation aneurysms represents a challenge both for the endovascular surgeon given the broad neck and for the neurosurgeon given that major branches of MCA can be adherent to the aneurism wall. The purpose of surgery is exclusion of the aneurysm from circulation, with preservation of normal vascular anatomy while minimizing the risk of recurrence at the clipping site (9, 10, 11). The latter is achieved by appropriate placement of the clips used to reconstruct the aneurysm without letting any dog ears, and this can be difficult to achieve in cases where the clip slides on atheromatous vessels. It is very important to control the clipping in order to make sure that no branch is occluded and there is no aneurysm remnant. Even though it is not available in our service indocyanine-green is very useful as a proof that the perfusion of the branches distal to the aneurysm is adequate.

We reconstructed the aneurysm using 4 Yasargil clips two straight and two curved applied in such a fashion as to clip the base of the aneurysm without injuring or obliterating the branches that crossed on the surface of the aneurysm (4, 5, 8).

In cases where the branches cannot be dissected from the fragile aneurysm wall, using fenestrated clips alone or stacked together to create tubes around the branch should be considered (13). Unfortunately we had no such clips available for this surgery.

In giant aneurysms or in those large unclipable, more difficult repair techniques including excision of the aneurysm and reanastomosing the vessels, or simply resuturing the arterial wall after resecting the aneurysm with or without a high flow or a low flow bypass are to be taken into account (2, 5). Of note is also the technique of bipolar shrinkage of the aneurysm which makes it smaller, more easily to dissect from the adherences and more clipable. This technique though is very risky in aneurysms with very thin walls and in those very adherent to the
branches. The technique used is a good option for clipping large MCA bifurcation aneurysms whose dome and neck cannot be fully dissected from the adherences.

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References
2. Mrak, Goran; Paladino, Josip; Stambolija, Vasilije; Jacob Nemir; Laligam N. Sekhar. 2014. Treatment of Giant and Large Fusiform MCA Aneurysms With Excision and Interposition Radial Artery Graft in a Four Year Old Child. Neurosurgery., 10:172-177
4. Rodríguez-Hernández, Ana; Gabarrós, Andreu; Lawton, Michael T.; 2012; Contralateral Clipping of Middle Cerebral Artery Aneurysms: Rationale, Indications, and Surgical Technique Neurosurgery. 71():ons116-ons124.
5. Nossek, Erez; Costantino, Peter; Eisenberg, Mark; More,2014; Internal Maxillary Artery to Middle Cerebral Artery Bypass: Intratemporal Approach for Subcranial-Intracranial (SC-IC) Bypass Neurosurgery., POST ACCEPTANCE, 10 March 2014
8. Leena Kivipelto, M.D., Ph.D., Mika Niemelä, M.D., Ph.D., Torstein Meling, M.D., Ph.D., Martin Lehecka, M.D., Ph.D., Hanna Lehto, M.D., and Juha Hernesniemi, M.D., Ph.D. ;Feb 2014; Bypass surgery for complex middle cerebral artery aneurysms: impact of the exact location in the MCA tree: Clinical article Journal of Neurosurgery / Vol. 120 / No. 2, Pages 398-408
11. Rodríguez-Hernández, Ana; Lawton, Michael T.; June 2012; Flash Fluorescence With Indocyanine Green Videoangiography to Identify the Recipient Artery for Bypass With Distal Middle Cerebral Artery Aneurysms: Operative Technique Neurosurgery. 70():ons209-ons220.
Aneurysms of the Middle Cerebral Artery Proximal Segment (M1) · Anatomical and Therapeutic Considerations · Revision of A Series. Analysis of a series of the pre bifurcation segment aneurysms

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Abstract

Aneurysms of the middle cerebral artery represent almost a third of all the aneurysms of the circle of Willis anterior sector. Among them, those located at its so-called M1 segment (from its origin up to the bifurcation) range between 2% and 7% of all the aneurysms. It is highly important to know the anatomy of the M1 segment, as well as of the arterial branches that arise from it, since causing its damage during dissection or occlusion of an aneurysm may determine the neurological sequelae.

The authors of the present work, based on a recent anatomical analysis carried out by one of them (FM), have performed a study of the aneurysms of the M1 segment in a series of 1059 aneurysms treated with surgery along 25 years. At the mentioned location 23 aneurysms were found, which represented 2.2% of the total operated aneurysms. The cases, location of the aneurysms and their relation with the early branches of the middle cerebral artery were studied, as well as the surgical difficulties that they pose.

A review of the scanty bibliography referring specifically to the aneurysms in this topography has been carried out.

Keywords: Cerebral aneurysms. Aneurysms of the middle cerebral artery, M1 segment

Introduction

The middle cerebral artery can be considered as the continuation of the carotid artery after the origin of the anterior cerebral artery or one of the two arteries in which the carotid bifurcates. Due to its anatomical disposition, it follows the carotid artery blood flow direction. The knowledge of this anatomical and physiological fact is very important when deciding how to treat an aneurysm of the middle cerebral artery. From the beginning of the endovascular therapy with coils, the aneurysms of such topography have been those which have posed and still pose most difficulties to endovascular surgeons. They are the aneurysms with the highest percentages of recanalization and they often demand retreatment, often incomplete and not without complications, during the procedure as well as afterwards. It may be due to these difficulties that, in the cooperative work ISAT, the aneurysms of the middle cerebral artery treated with endovascular therapy are fewer in percentage terms. The microneurosurgical practice at the laboratory as well as the experience of neurosurgeons with trans-sylvian approaches make the surgical treatment of aneurysms of the middle cerebral artery not to pose major technical difficulties and thus leads to good surgical results. For the reasons above explained, the aneurysms of the middle cerebral artery are considered, in the first instance, for conventional surgery.

Most of the aneurysms of the segment are located at the level of the middle cerebral artery bifurcation, that is, at the M1-M2 union. A low percentage are proximal, that is, at the M1 segment, which starts from the origin of the artery up to its bifurcation, and the same can be said about distal aneurysms (M3 and M4 segments). The latter present a different etiology from that of most of the aneurysms and are not the subject of the present study.

The aneurysms of the proximal segment of the middle cerebral artery (M1) are linked at their origin to the so-called ‘early branches’ of the artery. The predominating arteries are the anterior temporal artery and the small perforating arteries that irrigate the basal ganglia region.

Although the percentage of aneurysms of the M1 segment is very low (2% to 7% of the total aneurysms), it is very important to know their relations and their origin according to their topography and direction, in order to know to which artery they are linked, which must be sought and respected during the dissection.
At the M1 segment originate what we call the early branches of the middle cerebral artery. Their number is variable. Among the early branches, the most frequent are the temporopolar, the anterior temporal and the orbitofrontal ones. In addition to this, and of minor caliber, are the perforating arteries that irrigate the basal ganglia region. It is exactly in relation with the early branches where the aneurysms of the M1 segment usually originate. Their location and direction will be in accordance with the artery they are related to. Despite the scanty bibliography available on aneurysms of the M1 segment of the middle cerebral artery and the low number of this kind of aneurysms treated by the authors of the present study, it is clear that, in principle, the aneurysms of this segment should not pose major difficulties for their treatment. As regards the choice of the ideal treatment for these aneurysms, it is necessary to emphasize that, up to date, conventional surgery remains the treatment of choice, with low risk, a very high percentage of complete occlusion and with a low percentage of neurological sequela. Besides what is already known about the middle cerebral artery, the artery that because of its anatomical disposition and the direction of the flow continues from the carotid, the nondespicable percentages of the aneurysm reopening either with appearance of the neck or due to coil compaction at the base when the endovascular therapy was the choice, lead to opt conventional surgery in principle for the treatment of these aneurysms. It is worth emphasizing that with the constant advances in endovascular therapy and with the help of the placement of stents or other devices at the origin of the aneurysm may, in a probably not so distant future, tip the scales in favor of the endovascular therapy over surgery for these aneurysms. However, nowadays evidence shows that surgery in trained hands has an almost null mortality and a very low morbidity; this is said for the aneurysms of middle cerebral arteries in general. The small group that the proximal aneurysms represent (M1 segment), pose a different challenge to the neurosurgeon. A priori, they could be considered simpler to treat (clipping under microscope), provided that it is not necessary to dissect the main divisional branches of the middle cerebral artery. However, by no means is to be underestimated the fact that these aneurysms arise in relation to the origin of some early artery of the middle cerebral artery. It should not be thought that these early branches are of scanty functional value. As it has been demonstrated in anatomical studies and as the authors analyze the recent study directed by Dr. F. Martinez-, these early branches irrigate eloquent areas of the brain. Their damage while dissection (coagulation, for example) as well as their inclusion in the clip that closes the neck of the aneurysm can determine an ischemic lesion with functional repercussion, either transient or permanent. Therefore, when an early aneurysm is diagnosed, surgery must be undertaken with the conviction that it is necessary to seek and respect these early branches during dissection. The main arteries (early temporal, orbitofrontal) usually have a caliber that makes them easily identifiable under the magnified vision of the microscope. An aneurysm originating in one of these arteries must always be dissected for the artery not to remain included in the clip. It is worth emphasizing that, unlike other locations, in most of the cases found by the authors these arteries arise at the neck of the aneurysm itself, hence the dissection must be distal to them and, on placing the clip, it is necessary not only to respect them but also avoid their compression, which can lead to a later thrombosis. Even more difficult is the case where an aneurysm arises from a perforating branch, which usually irrigates the ganglio-basal region. These arteries are very small although in relation to the aneurysm and they have a thicker caliber than usual. Since they are small, if surgery is not performed under the microscope with high magnification they may not be identified and thus may get included in the clip, with the consequent infarction of an area in the basal ganglia region, which may or may not lead to deficits and poor clinical results. In addition to this, in the small series of the authors, approximately 70% of the aneurysms had a broad neck (neck/fundus ratio), which is important at the time of placing a clip. It is a well-known fact that a broad-necked aneurysm can determine a compromise in the parent artery or of the branch where it originates at the moment of placing a clip. This risk is higher if the related artery is of smaller caliber.

Therefore, a good knowledge of the anatomy is indispensable, as well as a careful study of the imaging is required, which must be of good quality in order to identify the branch in which the aneurysm originates and the other branches present at the proximal sector, in order not to damage them during the dissection of the sylvian cistern and to always identify the branch that gives origin to the aneurysm. This branch must be dissected and separated from the neck of the malformation so that it ‘does not suffer’ at the moment of placing the clip.
On occasions, as it happens in aneurysms of the middle cerebral artery bifurcation, it is necessary to perform transient or temporary proximal clippings in order to facilitate the dissection. Other times it may be necessary to puncture and empty the aneurysm, so as to complete the separation of the efferent branches and to facilitate, through the loss of tension in the aneurysm, the definitive clip placement, with no damage or tightening of the vessels. Therefore, it is necessary that any surgery for cerebral aneurysms and even more those of middle cerebral arteries, includes a neuro-anesthesiologist trained in cerebral protection as well as neuro-physiological monitoring for the control of the cerebral function, both during the temporary clipping and after the placement of a definitive clip. In such way, the surgeon works comfortably and offers the patient better outcomes.

Another fact to take into consideration in aneurysms of the proximal segment of the middle cerebral artery is that, in a nondespicable percentage of the cases, the aneurysm is embedded in the cerebral parenchyma. This is more frequent in the aneurysms which originate in relation to perforating arteries. More than never in these cases the dissection must be always cisternal and without the use of retractors. The separation from the parenchyma can lead to premature rupture of the aneurysm, even before visualizing it or having dominated the neck. It is recommended to start the cisternal dissection distal from the aneurysm (for example, at an opercular level), to seek the middle cerebral artery or its efferent branches and to continue along the cistern in proximal direction up to the aneurysm. Even, as it is reached, it is necessary to continue proximally, in order to dominate the artery proximally in case a transitory clipping is necessary. If the dissection is always kept cisternal and without the use of retractors, accidents like bleedings of the malformation can be a rare occurrence. It can be argued that in cases of acute surgery with bleedings, the dissection and vision are not easy. In these cases, a slow and careful dissection is recommended, always following the artery and with continuous irrigation in order to wash away the blood from the cistern and to clear its visualization.

In the aneurysms that originate from the proximal branches of larger caliber, and mainly in the big aneurysms that relate to the anterior temporal or the orbitofrontal arteries, it may be suspected that the bottom of the aneurysm could be in contact with the dura mater or, as happened in one of the cases operated by the authors, be firmly adhered to it. In other three cases of the series there was contact with the dura mater, but the adherence was not firm and it was possible to separate it with dissectors without incidents. In cases like this, the dissection must be very carefully performed right from the opening of the dura mater, which should never be sharply separated from the arachnoid, since this maneuver may cause the aneurysmal rupture, with profuse bleedings, even before starting the cisternal dissection.

Conclusions

As a conclusion, it can be said that the aneurysms of the proximal segment of the middle cerebral artery (M1) represent a small sub-group within the vascular malformations of this artery. The knowledge about the artery and its early branches is fundamental at the moment of planning and undertaking the surgery of these aneurysms. They should never be considered easy to treat beforehand, since in a high percentage of the cases they are broad-necked. Moreover, they are always related to some early branch of the artery, and in general the origin of these branches is firmly linked to the neck, or even its visualization is hidden by the aneurysm itself. Extreme care must be taken during the dissection, seeking the branch that gives origin to the aneurysm and clipping the malformation distal to that artery in a way not to damage it. Ignorance regarding these facts will unfailingly lead to cerebral lesions, which can lead to permanent neurological sequelae.

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Bibliography

Cerebral Aneurysms Treatment & Management

Medical Care

Prehospital care should include assessment of vital signs and neurological status. Airway, breathing, and circulation should be addressed with endotracheal intubation, if necessary, and establishment of intravenous access.

Medical therapy of cerebral aneurysms involves general supportive measures and prevention of complications for individuals who are in the periprocedural period or are poor surgical candidates. Treatment decisions should be based on the clinical status of the patient, vascular anatomy of the aneurysm, and surgical or endovascular considerations.

Medical management of aneurysmal SAH is orchestrated in the ICU, with cardiac monitoring and placement of an arterial line.

Prior to definitive aneurysm treatment, medical approaches involve control of hypertension, administration of calcium channel blockers, and prevention of seizures.

Following surgical or endovascular aneurysm treatment, blood pressure is maintained at higher levels to diminish complications associated with vasospasm. Vasospasm usually occurs between days 3 and 21, presenting with headache, decreased level of consciousness, and variable neurological deficits. Serial TCD may be employed to detect trends in cerebral blood flow during this period.

Induced hypertension, hypervolemia, and hemodilution (ie, "triple-H therapy") aimed to maintain adequate cerebral perfusion pressure in the setting of impaired cerebrovascular autoregulation. However, guidelines have moved toward maintenance of euvolemia and induced hypertension based on recent literature.

Intraarterial papaverine or endovascular balloon angioplasty may be used to treat vasospasm in select patients.

Infectious aneurysms are friable, with an increased propensity for hemorrhage. Anticoagulation is avoided in this setting. As these lesions resolve with antibiotic therapy, surgical approaches usually are deferred. Regression or evolution of these aneurysms is monitored with serial angiography.