Middle Cerebral Artery Aneurysm Endovascular and Surgical Therapies

Comprehensive Literature Review and Local Experience

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KEYWORDS

• Middle cerebral artery • Aneurysm • Clipping • Coiling • Endovascular • Intracranial aneurysm

KEY POINTS

- The middle cerebral artery (MCA) is the most common location for cerebral aneurysms and is associated with a lower risk of rupture than aneurysms located in the anterior or posterior communicating arteries.
- There is no definitive evidence to support the superiority of clipping over coiling to treat middle cerebral artery aneurysm (MCAA) or vice versa.
- The current available data and review of the literature indicate that the feasibility of treating the MCAA with endovascular therapy (ET) as the first choice of treatment in cohorts of nonselected aneurysms exceeds 90%.
- No significant increase in the risk of rebleeding with endovascular approaches was shown, and there are no significant differences in the long-term morbidity and mortality (M&M) between the 2 treatments. However, the review of the literature indicates that treatment of MCAAs is also associated with low M&M rates with surgical clipping in unruptured aneurysms.
- Based on the literature, it seems that there is no significant difference between the 2 therapies, with only hypothetical advantages of one approach over the other. A randomized clinical trial comparing the 2 approaches in nonselected cases with long-term follow-up will shed light on which patients may benefit from one approach over another.

INTRODUCTION

Since the publication of the International Subarachnoid Aneurysm Trial (ISAT) and Barrow Ruptured Aneurysm Treatment (BRAT) randomized clinical trials, ET is the most frequently used approach for treating cerebral aneurysms.[1–5] Incremental improvements of interventional

Disclosures: None.
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Neurosurg Clin N Am 25 (2014) 455–469
http://dx.doi.org/10.1016/j.nec.2014.04.005
1042-3680/14/$ – see front matter

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techniques now permit treatment of more complex cerebral aneurysms endovascularly, resulting in a higher proportion of aneurysms being treated with ET than with open surgical techniques.[6] Despite the mounting evidence, the debate of coiling versus clipping continues to persist, most vigorously directed at the treatment of MCAAs. More emphasis is placed on choosing treatment based on clinical factors, complex anatomic and morphologic features (including age, location, size, projection, and relationship with branching vessels), and the potential of lifelong durability over the initial gain of coiling safety.

This ongoing controversy is well illustrated by the unresolved question regarding the best approach to treating MCAAs and the lack of consensus on which treatment provides balanced safety and long-term protection. It is assumed that the specific anatomic aneurysmal location of the MCA may be more suitable to open surgical therapy than to ET. Although the MCA is an appealing location for surgical treatment with a direct and feasible approach, there is potential difficulty in cases with early vasospasm, as well as potential additional morbidity of the open surgical approach, such as retraction injury and perioperative hematoma. These difficulties and complications may be avoided by an endovascular approach; however, no randomized controlled trial data currently exist to specifically guide MCAA treatment decisions.

The lack of consensus on best treatment practices may have originated from initial data on MCAA coiling outcomes collected during early-era ET when coiling techniques had limited feasibility in treating challenging complex-shaped aneurysms. The introduction of advanced microcatheter designs for superior aneurysm access, complex 3-dimensional coil designs coupled with neck-bridging microstents, and balloon-assisted coiling options that offer safer and more dense packing result in feasibility rates for ET that exceed 90%.[7–11] In a study of 300 MCAAs by Mortimer and colleagues,[11] the feasibility of MCAA coiling as a primary treatment was shown to be approximately 95.8%. In this monograph, we provide a comprehensive literature review of MCAA coiling and clipping, then present our initial experience of MCAA coiling of nonselective consecutive cases.

MCA EMBRYOLOGY AND ANATOMY

An understanding of MCA embryology, anatomy, and expected anomalies is imperative to best treatment approach planning. During the 8th to 12th week of gestation, the distal primitive internal carotid artery (ICA) and its anterior cerebral artery (ACA) divide into the anterior choroidal artery and numerous small arterial twigs. The latter develops into the future anterior and middle embryologic cerebral arteries. This rete coalesces into the main MCA trunk, and the remaining twigs are the future perforators. The MCA is thus a continuation of the ICA. Failure to coalesce can lead to accessory MCA and a dominant anterior temporal artery. These variations become important in the discussion of the accessory MCA types.

From microsurgical data, the MCA outer diameter is 3 ± 0.1 mm bilaterally with a length of 15 ± 1.1 mm in the right hemisphere and 15.7 ± 1.3 mm in the left hemisphere.[12] However, in an autopsy study of 610 MCAs, the horizontal segment length was 16 mm (range 5–30 mm), with a diameter of 3 to 5 mm.[13] The MCA main trunk horizontal segment is referred to as M1 (sphenoidal), followed by the M2 (insular), then M3 (opercular), and finally M4 (cortical) segments.[13,14]

The MCA horizontal segment branching patterns are bifurcation (78%–90% of cases), trifurcation (12%), and multiple branches (10%), with the subsequent branching being mainly bifurcated.[13,14] A true trifurcation may be confused with a dominant intermediate trunk with a gap between the latter and the bifurcation point. A dominant trunk was found to be close to the MCA division, masking as a true trifurcation in 15% of cases. In 55% of cases, it originates within a short distance of one of the MCA divisions, whereas in 30% of cases, it originates distal to the MCA divisions. The dominant intermediate trunk originated more commonly from the superior division. The more proximal the intermediate trunk is to the MCA division point, the larger its contribution to the cortical territories.[15] The intermediate trunk commonly supplies the parietal lobe. The superior trunk supplies the frontal convexity, and the inferior division supplies the temporal lobe in conjunction with the posterior cerebral artery and part of the parietal lobe, depending on the dominance of each division.

The anterior temporal artery is the first branch of the M1 segment and a common location of proximal M1 aneurysms, as was seen in 19 of the 23 specimens in one autopsy study and in all MCA samples in another study.[13,16] In addition, the perforators (Charcot striate arteries, varies from 6 to 20 perforators) are a common location for proximal M1 aneurysms.[13] The perforators can originate from the proximal M1 segment (51.1%), distal M1 segment and the first branching point (25.6%), or from one of the MCA/M2 branches distal to the first division (20.3%).[13]

Accessory MCA was found in 3% of the autopsies and 0.12% of the magnetic resonance