Middle cerebral artery bifurcation aneurysm

Of the middle cerebral artery aneurysms, those located at the main bifurcation of the middle cerebral artery (MCA) (MbifA) are by far the most frequent.

Middle cerebral artery bifurcation aneurysms are often broad necked and may involve one or both branches of the bifurcation (M2s). The anatomical and hemodynamic features of MbifAs make them usually more favorable for microneurosurgical treatment. In population-based services, MbifAs are frequent targets of elective surgery (unruptured), acute surgery (ruptured), and emergency surgery (large ICH), even advanced approaches (giant). The challenge is to clip the neck adequately, without neck remnants, while preserving the bifurcational flow.

In the series of Elsharkawy et al. the main MCA bifurcation was the most common location for MCA aneurysms, harboring 829 aneurysms (63%). The 406 M1 aneurysms comprised 242 M1 early cortical branch aneurysms (60%) and 164 M1 lenticulostriate artery aneurysms (40%). We found 106 MCA aneurysms (8%) at the origin of large early frontal branches simulating M2 trunks liable to be misclassified as MCA bifurcation aneurysms. Even though 51% of the 407 ruptured MCA aneurysms were associated with an intracerebral hematoma, this did not affect the classification.

Studying MCA angioarchitecture and applying the 4-group classification of MCA aneurysms is practical and facilitates the accurate classification of MCA aneurysms, helping to improve surgical outcome.

From the analysis of 61 MCA bifurcation aneurysms, 4 shape pattern categories were created that allowed the classification of 56 aneurysms (91.8%). The number of aneurysms allotted to each shape cluster was 10 (16.4%) in category 1, 24 (39.3%) in category 2, 7 (11.5%) in category 3, and 15 (24.6%) in category 4.

Through the use of anatomic visual cues, MCA bifurcation aneurysms can be grouped into a small number of shape patterns with an associated clip solution. Implementing these principles within current neurosurgery training paradigms can provide a tool that allows more efficient transition from novice to cerebrovascular expert.

While most aneurysms that originate at the middle cerebral artery (MCA) bifurcation or trifurcation have a saccular geometry, some MCA aneurysms may exhibit a fusiform morphology and incorporate not only the proximal MCA trunk but also major MCA branches. In contrast to saccular aneurysms, fusiform aneurysms represent a distinct subset of intracranial aneurysms with unique underlying pathological features, hemodynamic forces, anatomical distribution, as well as natural history that governs their treatment.

Case series

A total of 28 patients with 32 bifurcation aneurysms of the middle cerebral artery > 3 mm in size were retrospectively selected for this study. Magnetic Resonance Vessel Wall Imaging were reviewed, and the aneurysm wall enhancement (AWE) pattern of each aneurysm was classified as no AWE, partial AWE, and circumferential AWE. Computational fluid dynamics were used to calculate the hemodynamic variables of each aneurysm. Univariate and multivariate analyses investigated the
association between AWE and hemodynamic variables.

AWE was present in 13 aneurysms (40.6%), with 7 (21.9%) showing partial AWE and 6 (18.7%) showing circumferential AWE. Kruskal-Wallis H analysis revealed that hemodynamic variables including wall shear stress (WSS), oscillatory shear index, aneurysm pressure (AP), relative residence time, and low shear area (LSA) were significantly associated with AWE (p < 0.05). Further ordinal logistic regression analysis found that WSS was the only factor with a significant association with AWE (p = 0.048); similar trends were identified for LSA (p = 0.055) and AP (p = 0.058). Spearman's correlation analysis showed that AWE was negatively correlated with WSS (rs = -0.622, p < 0.001) and AP (rs = -0.535, p = 0.002) but positively correlated with LSA (rs = 0.774, p < 0.001).

Low wall shear stress, low aneurysm pressure, and increased low shear area were associated with aneurysm wall enhancement on vessel wall magnetic resonance imaging in unruptured cerebral aneurysms. These abnormal hemodynamic parameters may induce inflammation and cause aneurysm wall enhancement. However, the association between these parameters and their underlying pathological mechanisms requires further investigation.

2017

Forty patients with 46 middle cerebral artery bifurcation aneurysms were treated microsurgically by the same surgeon. Aneurysms were classified according to shape and the Fisher test was applied to analyze the effect of morphology on the pre-operative and intra-operative rupture. Results:

Pre-operative and intra-operative ruptures were observed in 8/46 patients (17.4%) and 14/46 patients (30.4%) respectively. Thirty-two cases (69.6%) had no symptoms postoperatively, modified Rankin score (MRS) of 0; 6.5% had MRS of 1 (no significant disability); 13% had MRS of 2 (slight disability); 4.3% had moderately severe disability (MRS of 4); and there were 3 deaths (6.5%) post-operatively. The morphology was not directly related to the rupture rate. Conclusion:

In general, ruptures are not affected by the morphology or the studied variables. Larger series are needed to validate these outcomes.

2016

A total of 169 consecutive patients with 177 bifurcation-type MCAAs were reviewed from August 2011 to January 2016. Based on the clinical and morphologic characteristics findings, the risk factors of aneurysm rupture were assessed using statistical methods.

Age, cerebral atherosclerosis, no hypertension, hypertension grade 2 and coronary artery disease (CAD) were negatively correlated with aneurysm rupture. The mean diameter (MD) of the parent and two daughter arteries was negatively correlated with rupture. Aneurysms with irregularity, depth, width, maximum size, aspect ratio, depth-to-width ratio, bottleneck factor, and size ratio were positively correlated with rupture. The multivariate logistic regression model revealed that irregular shape (odds ratio (OR) 2.697) and aspect ratio (OR 3.723) were significantly and positively correlated with rupture, while cerebral atherosclerosis (OR 0.033), CAD (OR 0.080), and MD (OR 0.201) were negatively correlated with rupture. Receiver operating characteristic analysis revealed that the threshold value of the aspect ratio and MD were 0.96 and 2.43 mm, respectively.

Cerebral atherosclerosis and CAD are protective factors against rupture. Morphological characteristics such as an aneurysm with an irregular shape, a high aspect ratio (>0.96) and a small MD (<2.43 mm) are likely better predictors of rupture.
Technical nuances of clipping a middle cerebral artery bifurcation aneurysm


