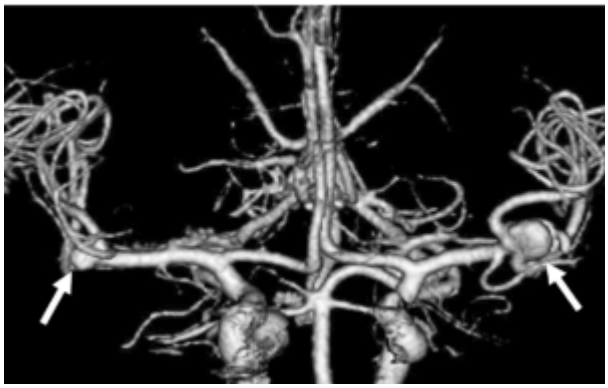
# Mirror aneurysm



Mirror aneurysms are a rare subtype of multiple aneurysms, located in identical or adjacent arterial segments bilaterally.

Different terminologies for mirror aneurysms have been described in previous reports (i.e., mirror intracranial multiple aneurysms, mirror-like intracranial aneurysm, and intracranial mirror aneurysm) along with different definitions [1) 2) 3) 4) 5) 6)].

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The phenomenon of mirror aneurysms makes it likely that an inborn weakness of the vessel wall is one of the underlying causes of cerebral aneurysms. Acquired alterations of the vessel wall and hemodynamic forces, on the other hand, also play an important role in the genesis of aneurysms [7)].

## Treatment

There are some controversies about the surgical treatment strategy of mirror aneurysms. Whether to choose 1-stage or 2-stage surgery, bilateral or unilateral craniotomy, or surgical or interventional treatment are the main points in dispute. In a review, the different surgery strategies faced by patients are discussed. Different surgical methods are adopted based on the patient's individual state and the location and size of the aneurysm. A new imaging method is introduced using 3D Slicer, which clearly recognizes the relationship among aneurysm, brain tissue, skull, and nerve. The 3D Slicer can help surgeons undertake adequate preoperative preparation. In addition, they also introduce some ruptured factors (e.g., age, gender, hypertension, morphologic, and hemodynamic) concerning mirror aneurysm. Systematic discussion of the controversies and methods in surgical treatment of mirror aneurysms may provide new perspectives in future research for the prevention and treatment of mirror aneurysms [8)].

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The treatment of the mirror aneurysm should be based on the location, size, shape of the aneurysm, the patient's clinical manifestations and the surgeon's experience to choose a personalized treatment [9)].

# Case series

Rajagopal et al. report a case series of 3 such patients amongst whom one of them had 3 sets of mirror aneurysms and the other patient had 2 sets of mirror aneurysm on the same arterial segment which has not been reported till date.

A retrospective analysis of 3 patients with incidentally detected multiple mirror aneurysms, who were treated with microsurgical clipping and coiling, was conducted. A systematic search was performed using the PUBMED database and relevant articles were reviewed with particular attention to incidence, associated conditions, risk factors and management strategies. Written informed consent was obtained from all of the patients for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request. This research work has been reported in line with the PROCESS criteria (Agha et al., 2018).

All the 3 patients were females with incidentally detected multiple mirror aneurysms. All the 3 patients were known Hypertensives. All the aneurysms were successfully clipped by a multistage, bilateral craniotomy except the one in the cavernous ICA, for which an endovascular procedure is planned. All of them had an uneventful postoperative course with the CT angiogram showing obliteration of all the clipped aneurysms except the one in the cavernous ICA.

Multiple mirror aneurysms represent a rare occurrence of a diverse pathology. Both these described types of cases have not been reported so far in the literature. The treatment strategy for mirror aneurysms should be determined individually based on the location, size, and morphology of the aneurysms, as well as, on the clinical manifestations of each patient [10)].

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67 cases of mirror aneurysms admitted from December 1997 to April 2018.

There were 20 males and 47 females with an average age of 53.6 years. Mirror aneurysms are mainly located in the posterior communicating artery and middle cerebral artery. Of 67 patients, 1-stage unilateral craniotomy with bilateral aneurysms in 18 cases, 1-stage bilateral craniotomy with bilateral aneurysms in 17 cases, staged treatment of bilateral aneurysms in 13 cases, and 19 cases only treated the responsible aneurysms. 57 cases with good recovery; 7 cases were self-care; 1 case was heavy disability; 2 cases were dead. In parallel, 8 cases had different degrees of cerebral infarction, 3 cases of hydrocephalus, 3 cases of oculomotor nerve injury, 2 cases died of cerebral hernia resulted from intracranial hypertension, and the remaining 53 cases were better.

The treatment of the mirror aneurysm should be based on the location, size, shape of the aneurysm, the patient's clinical manifestations and the surgeon's experience to choose a personalized treatment [11)].

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Out of a total of 338 subjects, 14 were identified harboring a total of 32 internal carotid artery mirror segment aneurysms that were treated with the pipeline embolization device and were consecutively enrolled into our study. We collected data on patient demographics, modified Rankin scale (mRS) at admission, aneurysm characteristics, clinical outcome at discharge, 3-9 and at 12-18 months as well as angiography results at follow-up.

Patients' mean age was 52.9 years; baseline mRS was 0 in all subjects. Pipeline embolization device

placement was successful in all cases. Post-treatment mRS remained 0 in 13/14 patients. One patient experienced a small intraparenchymal hemorrhage and subarachnoid hemorrhage, associated with a frontoparietal infarction resulting in right upper extremity weakness and aphasia (post-treatment mRS 3). His mRS evaluation remained stable at the 3-9-month follow-up. Three to 9-month follow-up angiography (13/14 subjects) showed complete aneurysm occlusion in 24/30 aneurysms (80%), near complete and partial occlusion in three of 30 (10%) aneurysms each. At the 9-month follow-up, one patient experienced a complete occlusion of the anterior temporal artery branch but did not present with any clinical deficits. No mRS changes were encountered over a median 6-month follow-up period. Mid-term follow-up angiography (12-18 months) available in eight of 14 subjects showed complete aneurysm occlusion in all patients. Mild intimal hyperplasia was observed in one patient.

Flow diversion technology can be used for the treatment of unruptured mirror segment aneurysms in selected patients [12].

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A retrospective review was conducted, aimed at 172 patients treated for 344 mirror aneurysms between January 2007 and December 2015. Aneurysms of similar nature but in asymmetric locations on the same-named vessels were excluded. All available records were examined and lesion characteristics, as well as treatment outcomes were assessed.

In study subjects (n = 172), mirror aneurysms most often involved middle cerebral artery bifurcation (n = 83), followed by a paraclinoid internal carotid artery (n = 50) and posterior communicating artery (n = 21). Most of the lesions (95.3%) measured ≤ 10 mm, and in 126 patients (74.6%), the size ratios were > 50%. Of the 344 aneurysms studied, coil embolization was undertaken in 217, surgical clipping in 62, and observation alone (no treatment) in 65. Coil embolization and surgical clipping were done bilaterally in 83 and 12 patients, respectively. In 12 patients, combined coiling and clipping were implemented on each side. Single-stage coil embolization of both the aneurysms was performed in 73 patients, with excellent post-procedural (85.6%) and follow-up (86.8%) occlusive results. There was no procedure-related morbidity or mortality.

By adopting different treatment strategies to different configurations and vascular sources, mirror aneurysms can be safely and effectively treated. If feasible, single-stage coil embolization should be considered as a reasonable treatment option for mirror aneurysms [13].

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Huang et al. performed a retrospective cohort study of 2641 intracranial aneurysms patients, who were admitted to our hospitals between January 2005 and June 2014. Patients were subdivided into three groups based on the inclusion criteria: (i) single (n=2250); (ii) non-mirror multiple (n=285); and (iii) mirror aneurysms (n=106). Clinical and demographic files of the three groups were collected and compared, and medical histories including stroke, hyperlipemia, hypertension, hyperglycemia, valvular heart disease were considered as potential risk factors. Potential morphological reasons for mirror cerebral aneurysms rupture, including aneurysms size, irregular walls and cerebral hemispheric dominance, were also compared. Our data showed that the male to female ratio of mirror aneurysms patients was 1:3.61, which was significantly different from that of single aneurysm (1:1.27) and multiple aneurysms (1:2.00). The prevalence of mirror aneurysms in women is higher than that in men ($P<0.001$). Older patients (especially 60-69 years old) also appear to be more vulnerable to mirror aneurysm than single aneurysm ($P<0.001$). In 84 mirror aneurysm patients the aneurysms were located on the internal carotid arteries (79.2%), most typically at the PComA or in the Cavernous ICA. Patients with medical history of hyperlipemia appear to have an increased risk of

harboring mirror aneurysms. Larger aneurysm size and presence of an irregular aneurysm wall appear to be the morphological factors that predispose for mirror aneurysms rupture [14].

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Weil et al. presented the sixth set of identical twins with multiple aneurysms. These cases represented the first report in the literature of multiple mirror aneurysms in identical twins. One twin presented with subarachnoid hemorrhage. Her sister, who was asymptomatic, had elective angiography which demonstrated multiple aneurysms in locations identical to her sister's aneurysms. In families in which a twin presents with subarachnoid hemorrhage, it is appropriate to recommend angiography to the asymptomatic twin [15].

## Case reports

Singh et al. reported a rare case of mirror image distal anterior cerebral aneurysm in a middle-aged male patient. The patient presented with severe headache and loss of consciousness. Angiography was done which suggested mirror imaging of two aneurysms located over both DACA. It was treated through microsurgical approach with a successful outcome.

Careful analysis of intracranial vasculature should be done using angiography, particularly in different views and stages to rule out multiple aneurysms at different locations in the same artery or at different arteries. Mirror images of bilateral DACA aneurysms are very rare. Fundamental surgical strategy of securing the parent artery and clipping the neck after meticulous dissection should be followed [16].

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A rare case of ruptured pericallosal (distal anterior cerebral) artery aneurysm, associated with another one in a mirror position was reported. The angiograms disclosed no variant vessels, such as azygos anterior cerebral artery and/or supreme anterior communicating artery. This patient, a 47-year-old woman, was successfully treated by surgery without any complication [17].

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