COMPLEX PARACLINOIDAL AND GIANT CAVERNOUS ANEURYSMS

Importance of preoperative evaluation with temporary balloon occlusion test and SPECT

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ABSTRACT - In the treatment of complex paraclinooidal and giant cavernous aneurysms, preservation of the patency of the internal carotid artery (ICA) is not always possible, and therapeutic occlusion of the carotid is still an important option for their management. A complete preoperative evaluation of the carotid reserve circulation, including the use of temporary balloon occlusion test and single photon emission computerized tomography (SPECT) should be included in the current paradigms of paraclinooidal and intracavernous aneurysms management. We present a series of fifteen patients with sixteen giant or complex carotid cavernous or ophtalmic aneurysms that were treated following a protocol for our preoperative decision-making analysis. Extracranial to intracranial saphenous vein bypass was reserved to the cases where carotid occlusion would be associated with high risk of ischemic complications and was performed in three patients. Besides the difficulties in dealing with those complex aneurysms, good clinical outcome was possible in our experience with the designed paradigm.

KEY WORDS: intracranial aneurysm, cavernous aneurysm, SPECT, balloon occlusion.

Advances in surgical techniques and cranial base approaches have greatly improved surgical outcomes with paraclinooidal aneurysms. However, they still represent a challenge for surgical management. A significant number of paraclinooidal aneurysms present as giant and complex aneurysms. Although most of them are manageable by direct clipping, occasionally proximal and distal temporary occlusion and defla-
tion of the pulsating mass might be required. In addition they may prove difficult to be clipped with maintenance of the patency of the ICA because of atherosclerosis and calcification at the neck and dome of the aneurysm. Endovascular procedures have become an alternative treatment1-3, although complete obliteration of the large and giant paracavernous aneurysms will not be feasible in many cases.

Symptomatic giant cavernous aneurysms are not amenable to direct surgery and are still nowadays candidates to carotid occlusion1-4. Therapeutic carotid occlusion remains an important treatment option for those difficult lesions but the most common and feared complication is cerebral ischemia5.

Extensive preoperative evaluation with the temporary balloon occlusion (TBO) test and SPECT may improve the detection of the patients at risk for permanent carotid occlusion.

**METHOD**

Fifteen patients with sixteen giant or complex aneurysms of the cavernous carotid or paracavernous aneurysms treated at the Hospital Universitário Clementino Fraga Filho (HUCFF) - UFRJ between March 1998 and March 2004 were included. Small carotid-ophthalmic and cavernous aneurysms were excluded of the present series. All the patients were submitted to the protocol for evaluation of the reserve of the collateral carotid circulation with the (TBO) followed by the study of the cerebral blood flow (CBF) with SPECT.

Appropriate balloon catheters were introduced via femoral artery and selective catheterization of the carotid artery under fluoroscopy was achieved with the Seldinger technique. In our Hospital, experience has been gained with two different non-detachable balloon occlusion catheters: Swan Ganz 5F and Meditech balloon catheters (Boston Scientific, Watertown, Mass, USA). Temporary complete occlusion of the internal carotid artery was hold during thirty minutes with continuous monitoring of the neurological status. The complete interruption of the blood flow in the internal carotid was checked by proximal injection of the contrast. If any neurological deficit occurred, the test was immediately interrupted and the balloon deflated. During temporary carotid occlusion collateral circulation was also studied by angiographic criteria with simultaneous injection of the contrast in the contra lateral carotid artery. The cross filling of the arteries were studied and special attention was paid to the simultaneous or delayed filling of the veins in the occluded side. Before deflation of the balloon, technetium-99m LL-ethyl cysteinate dimer (ECD) radioisotope was injected intravenously. After deflation of the balloon and withdraws of the catheter, the patient was sent to the SPECT suite. The SPECT study of the cerebral blood flow can be obtained until three hours after the injection of the radioisotope and reflects the blood flow at the exact moment of the injection of the technetium-99m during temporary carotid occlusion.

Definitive treatment strategy was decided after discussion among the members of the neurovascular team of neurosurgeons, neurologists and interventional neuroradiologists. The final approach was planned on a case-by-case basis according with the preoperative evaluation and the intraoperative findings. The ideal goal was the complete occlusion of the aneurysm with preservation of the carotid patency, and decompression of the neural structures in the giant and symptomatic lesions. Therapeutic carotid occlusion with surgical trapping or endovascular occlusions were reserved for the cases where the patency of the carotid could not be preserved. Prophylactic extracranial-intracranial bypass was performed only in the cases where the pretreatment evaluation showed that the patient has a moderate to high risk for carotid occlusion.

**RESULTS**

There were fifteen patients, fourteen female and one male, treated in the last five years, with sixteen giant or disomorphic paracavernous aneurysms included in the present series (Figs 1 and 2). All of them, with the exception of one young lady with a severe displasia of the cervical and petrous carotid artery associated with a fusiform aneurysm, were submitted to TBO. There were no complications related to the TBO. The summary of the results is demonstrated on the Table. Eleven patients were submitted to therapeutic carotid occlusion, eight with trapping and three with endovascular detachable balloon occlusion. In the fifteen patients treated in this series, twelve had an excellent clinical outcome without permanent deficits. Three patients had motor deficits. A 53 years-old lady passed the TBO-SPECT test but sustained a permanent motor deficit secondary to unintended surgical occlusion of perforator branches. A 42 year-old female patient had TOB-SPECT that showed mild defect and it was decided for occlusion and hypervolemic management in the intensive care unit. She developed hemiparesis in the fourth post-operative day of trapping of the carotid. Her motor deficit improved with hypervolemic and hypertensive therapy. The third patient that developed deficit, a 30 year-old female, was not able to have the TBO-SPECT test even though harboring a large petro cavernous aneurysm because of severe fibromuscular dysplasia of the parent carotid artery. She developed transient hemiparesis secondary to safenous vein bypass trombosis. One patient died of pulmonary sepsis in the seventh post-operative day, secondary to complications related to intraoperative rupture of a giant aneurysm with frontal lobe hematoma. In this particular case intraoperative bleeding secondary to the rupture of the aneurysm was controlled with trapping of the carotid, and an EC-IC bypass was
Fig 1. Case 14. Preoperative cerebral angiogram of the right internal carotid artery (A). 3-D angiogram (B). SPECT during the occlusion test showing symmetry of the cerebral perfusion (C). Postoperative cerebral angiogram (D).

Fig 2. Case 10. Preoperative cerebral angiograms of the right and left internal carotid arteries and basilar artery (A,B,C). Postoperative cerebral angiograms showing clipping of the multiple aneurysms and occlusion (trapping) of the left internal carotid artery with good crossfilling (D,E).
performed since the patient did not tolerate the TBO preoperative test. Even with this unfavorable evolution in this patient, EC-IC bypass was patent postoperatively and CT scan did not evidenced any cerebral ischemic infarction. At completion of this article there was no patient with delayed ischemic event.

**DISCUSSION**

Giant paraclinoidal and cavernous aneurysms traditionally have been difficult lesions to treat surgically. They are rare aneurysms and large experience can be achieved only in neurovascular reference centers. Paraclinoidal aneurysms are much more commonly find in females than in males, accounting for about 74 to 86% of patients in some surgical series6. In our series, females accounted for 92% of the patients. The association of the paraclinoidal aneurysms with multiple aneurysms is also common. Whenever possible, direct obliteration of the aneurysm is the most preferable treatment approach, given the fact that endovascular techniques continue to evolve and are still not satisfactory in the giant aneurysms. Combined ipsilateral and contra lateral clipping of bilateral paraclinoidal aneurysms by a single approach has been reported. Despite the continuing advances therapeutic carotid occlusion is still used for treatment of symptomatic intracavernous carotid aneurysms. The main indications for treatment are bleeding from rupture of the aneurysm to the sphenoid sinus, progressive ophthalmoplegia and untreatable pain. Direct surgical repair of intracavernous aneurysms is associated with high morbidity of the intracavernous nerves and is rarely used nowadays. Endovascular therapy with preservation of the patency of the parent vessel in these frequently giant aneurysms with broad necks is still not satisfactory with current

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endovascular technology and is unable to deal with the mass effect symptoms.

The majority of large and giant supraclinoidal aneurysms can be managed by direct surgical clip ligation using a variety of technical adjuncts including temporary occlusion with cerebral protection, and aneurysm deflation with retrograde suction. However, some giant and dimorphic paraclinoidal aneurysms are simply not amenable to direct clip ligation or endovascular obliteration because of very large neck, proximal extension into the cavernous sinus, dense calcification of the neck, intraluminal organized thrombus, or other physical factors that preclude obliteration of the sac with preservation of the parent vessel. In these cases, therapeutic carotid occlusion should be considered, with or without prophylactic extracranial-intracranial (EC-IC) bypass.

Despite the fact that many complex supraclinoidal aneurysms can be obliterated surgically or with endovascular procedures, pretreatment evaluation of the risk of carotid occlusion is mandatory. Appropriate flow augmentation procedures may be planned as needed or performed prophylactically. Even with all those technical advances morbidity and mortality is still high in direct surgery of giant paraclinoidal aneurysms.

Carotid balloon occlusion is an accepted method for the treatment of large and giant carotid aneurysms, with relatively low procedural complications. In almost all patients, the treatment will lead to a complete thrombosis of the aneurysm improving the symptoms of mass effect, and shrinkage of aneurysms on MRI. Although carotid balloon occlusion or trapping of the aneurysm are safe and effective treatment for the aneurysm itself, the outcome mainly depends on the patient's long-term tolerance to carotid occlusion. In a review of the literature comprising 516 patients, brain infarction occurred in 26% and mortality was 12% after permanent carotid occlusion without previous TBO. The acute ischemic stroke rate can be reduced to 4.7% with no mortality in the group evaluated preoperatively with TBO. Thus, TBO in awaked patients is reliable in predicting which patients are in high risk of acute ischemia but there are no solid evidences to corroborate such recommendation.

The policy of universal revascularization procedures for all the patients candidates to therapeutic carotid occlusion has been recommended by some authors, especially in the young patients, with higher cumulative risk of ischemia but there are no solid evidences to corroborate such recommendation.

Patency rates for EC-IC bypasses with saphenous vein grafts in previously published studies varied from 66 to 90%. The best results published show patency rates of 90% to 98% with the adoption of intraoperative angiography. However, these outstanding results would be difficult to duplicate at many neurosurgical centers. The long term patency of the saphenous vein grafts is also unknown. In a series of 202 vein grafts monitored for a mean of 6.5 years at the Mayo Clinic, 10 patients (8%) experienced late graft occlusions, with a calculated annual occlusion rate of 1 to 1.5%.
In a review of the literature on permanent occlusion of the carotid artery, the estimated long term risk for ischemic deficits is 0.8% / year of follow-up and the estimated risk for subarachnoid hemorrhage secondary to the development of de novo aneurysms is 0.4% / year. These low cumulative risks are insufficient to support the recommendation of universal revascularization. Carter, in a literature review, showed that the benefit of prevention of ischemic stroke in the patients submitted to EC-IC bypass is off-set by procedure-related infarctions secondary to problems like graft thrombosis. Another complications associated to an EC-IC bypass described are epidural hematoma (8%) and myocardial infarction (2%). Furthermore, procedure related mortality seems to be higher in the series of the patients submitted to universal revascularization versus therapeutic carotid occlusion after TBO evaluation and without bypass.

In conclusion, satisfactory clinical outcomes can be achieved in the management of the giant and complex paraclinoidal and cavernous aneurysms by direct surgery, trapping or endovascular carotid occlusion based on an extensive preoperative evaluation with TBO-SPECT.

Prophylactic EC-IC bypass should be used only for the uncommon high risk patients with limited hemodynamic reserve. Our paradigm for internal carotid artery reserve evaluation proved to be safe, reliable and should be added, whenever possible, to the management of the patients harboring those difficult lesions.

REFERENCES