Journal of the Neurological Sciences 372 (2017) 250–255

Contents lists available at ScienceDirect

Journal of the Neurological Sciences

journal homepage: www.elsevier.com/locate/jns

Parent vessel occlusion for treatment of cerebral aneurysms: Is there still an indication? A series of 17 patients

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ARTICLE INFO

Article history:
Received 11 June 2016
Received in revised form 27 October 2016
Accepted 22 November 2016
Available online 23 November 2016

Keywords:
Aneurysm
Balloon test occlusion
Parent vessel occlusion
Giant aneurysm

ABSTRACT

Introduction/purpose: Flow diversion has allowed cerebrovascular neurosurgeons and neurointerventionalists to treat complex, large aneurysms, previously treated with trapping, bypass, and/or parent vessel sacrifice. However, a minority of aneurysms remain that cannot be treated endovascularly, and microsurgical treatment is too dangerous. However, balloon test occlusion (macro and micro), micro WADA testing, ICG, intra-angiography and intra-operative monitoring are all available to clinically test the hypothesis that vessel sacrifice is safe. We describe a dual-institution series of aneurysms successfully treated with parent vessel occlusion (PVO).
Materials/methods: Prospectively collected databases of all endovascular and open cerebrovascular cases performed at Maine Medical Center and Vanderbilt University Medical Center from 2011 to 2013 were screened for patients treated with primary vessel sacrifice. A total of 817 patients were screened and 17 patients were identified who underwent parent vessel sacrifice as primary treatment.
Results: All 17 patients primarily treated with PVO are described below. Nine patients presented with SAH, and 3/17 involved anterior circulation. Complete occlusion was achieved in 15/17 patients. In the remaining 2 patients, significant reduction in the aneurysm occurred. Modified Rankin Score (mRS) of 0, signifying complete independence, was achieved for 16/17 patients. One patient died due to an extracranial process.
Conclusions: Parent vessel sacrifice remains a viable and durable solution in select ruptured and unruptured intracranial aneurysms. Many adjuncts are available to aid in the decision making. In this small series, patients naturally divided into vertebral dissecting aneurysms, giant aneurysms and small distal aneurysms. Outcomes were favorable in this highly selected group.

1. Introduction

Parent vessel occlusion (PVO) is a traditional method for treating aneurysms that are not amenable to direct coiling/clipping or particularly complex saccular or fusiform aneurysms. It has been successfully implemented in the treatment of aneurysms involving the vertebrobasilar junction [1–4], posterior cerebral artery [5–7] and peripheral cerebral aneurysms [8,9] when adequate collateral flow is present. Flow diverters have introduced another class of treatment options for these complex aneurysms that historically would have undergone trapping, parent vessel sacrifice, or bypass. However, PVO still remains a viable option. There are many well-established diagnostic modalities to determine feasibility of PVO, including intra-operative monitoring, balloon test occlusion (BTO), and Wada testing. These can aid in patient selection to ensure that PVO, if indicated, is safe. Therefore, interventionalists and neurosurgeons should keep PVO in their armamentarium of treatment options. Here we review the experiences of two centers using PVO as a favorable solution in a select group of patients with intracranial aneurysms.

Abbreviations: AICA, Anterior Inferior Cerebellar Artery; AVM, Arterial-venous Malformation; BTO, Balloon test occlusion; ICA, Internal Carotid Artery; ICG, Indocyanine green; MMC, Maine Medical Center; MCA, Middle Cerebral Artery; mRS, Modified Rankin Score; NBCA, n-butyl cyanoacrylate; PVO, Parent Vessel Occlusion; PICA, Posterior inferior cerebellar artery; SAH, Subarachnoid hemorrhage; SCA, Superior Cerebellar Artery and Vanderbilt University Medical Center (VUMC).

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http://dx.doi.org/10.1016/j.jns.2016.11.057

2. Methods

2.1. Study design and data collection

A retrospective case series was obtained from two prospectively collected databases of all patients undergoing endovascular and open cerebrovascular treatment over a two-year period at Maine Medical Center (MMC) and Vanderbilt University Medical Center (VUMC). From February 2011 to April 2013, 817 patient records were screened between both databases, and 17 patients were identified who underwent PVO as the primary treatment for an aneurysm not amenable to direct embolization or clipping (Table 1). This is a highly selected group representing approximately 2–3 patients per year from each medical center where the total combined annual number of aneurysm presenting cases is greater than 250.

The electronic medical records for these patients were reviewed, using clinic notes, operative notes, and angiographic images. Demographic variables were collected and defined as age and sex. Clinical variables were collected and defined as presence of subarachnoid hemorrhage (SAH), aneurysm location, aneurysm morphology, and treatment modality. Outcome variables were collected and defined as aneurysm occlusion on follow-up angiography, presence of postoperative complications, and functional outcome as measured by the modified Rankin score (mRS) at last follow-up.

2.2. Operative technique

All patients were treated endovascularly or with open sacrifice, as depicted in Table 1. Preoperatively, a BTO was performed in line with technique previously published [10]. The patient was kept awake, and groin access was obtained through the right common femoral artery up to the involved parent vessel. A balloon was then inflated in the proximal segment of the involved vessel to complete occlusion. Neurologic exams were obtained in the 10–20 min after occlusion, and the balloon was immediately deflated with any deviation in exam. Given the extensive collateral circulation, BTO was not used in everyone, but rather select patients.

For open PVO, the patient was intubated, a right groin sheath was placed and a pre-procedure angiogram performed. The patient was then positioned on the appropriate side of the aneurysm. Neuromonitoring with SSEP and EEG were utilized. For distal vertebral artery and PICA lesions, an S-shaped incision for a far-lateral subocippital craniotomy was made, from the superior pinna running inferiorly to the midline underneath the inion to the spinous process of C2. Pericranium was harvested during exposure for the duraplasty. The avascular midline was followed down to the spinous process of C1 and C2. A craniotomy was performed from the transverse-sigmoid junction to the midline of the foramen magnum. The ipsilateral lamina of C1 was removed, with care taken to visualize the extradural vertebral artery. The dura was opened from the transverse-sigmoid junction to the arch of C1. After the operating microscope was brought into the field, the arachnoid was opened and CSF was drained from the cisterna magna. Based on location of the pathology along the vertebral artery or PICA, surgical corridors between the inferior cranial nerve IX, X and XI in the middle, and VII and VIII superiorly are utilized to safely sacrifice the involved vessel.

Though most open cases involved the posterior circulation, for any anterior circulation procedures, a standard curvilinear pterional incision was made and a myocutaneous flap was reflected anteriorly. Exposure of the keyhole and the temporal bone was achieved, and a standard pterional craniotomy bone flap was turned. In the case of anterior circulation sacrifice, the sphenoid wing was aggressively drilled down and flattened. If periorbita was encountered, the area was immediately waxed. A curvilinear dural incision was then made after hemostasis was achieved, and the microscope was brought into the field. A subfrontal approach was taken. The olfactory tract was found and followed to the optic nerve, leading to the supraoptic cistern, which was then decompressed. The ICA was then located, and the sylvian fissure was carefully opened with sharp dissection. Depending on the pathology, the involved intracranial vessel was dissected out, able to obtain proximal and distal control when needed.

For either approach, a combination of bayoneted and/or straight clips was used to ensure the aneurysm and parent vessel were occluded. Once the necessary vessel sacrifice was performed, attention was turned to hemostasis and closure. The dura was approximated, a pericranial graft was sewed in when necessary, the bone flap was replaced, and the scalp was closed in a usual fashion. A post-procedure angiogram was then performed to confirm occlusion of the parent vessel. A representative open case is presented in Fig. 1.

For endovascular PVO, the patient was intubated and positioned supine in the angiogram suite. Whereas the patient was kept awake for any BTO or Wada test, all patients were placed under general anesthesia for endovascular PVO. The groin area was prepped and draped in a sterile fashion. Access into the right common femoral artery with a needle,

Table 1
Patient demographics and location of aneurysm along with treatment method and post-operative aneurysm occlusion status, procedural complications and mRS. SAH: Subarachnoid hemorrhage, PICA: Posterior inferior cerebellar artery, MCA: Middle Cerebral Artery, SCA: Superior Cerebellar Artery, ICA: Internal Carotid Artery, AICA: Anterior Inferior Cerebellar Artery, AVM: Arterial-venous Malformation, NBCA: n-butyl cyanoacrylate, mRS: Modified Rankin Score, I: Incomplete, C: Complete.

Case	SAH	Aneurysm type and morphology	Treatment	Occlusion	Complication	mRS
1	N	Dissecting vertebral	Coil	I	None	0
2	N	Giant ICA	Coil	C	None	0
3	Y	Distal PICA	NBCA	C	None	0
4	Y	Dissecting vertebral	Coil	C	None	0
5	Y	Dissecting vertebral	Coil	C	None	0
6	Y	Distal mycotic MCA	Onyx	C	SMA infarct	0
7	N	Giant basilar	Mid basilar clipping	I	MCA infarct	0
8	N	Giant PICA	Distal clipping	C	None	0
9	Y	Dissecting vertebral	Coil	C	None	0
10	Y	Distal PICA	Clip trapping	C	None	0
11	N	Distal SCA	Coil	C	Scattered SCA infarcts	0
12	N	Giant vertebral	Coil + Amplatzer	C	None	0
13	N	Residual distal SCA feeding aneurysm after AVM resection	Coil	C	None	0
14	Y	Ruptured AICA feeding aneurysm to AVM	Onyx	C	Tonsillar infarct. Death from bleeding esophageal varices 2.5 weeks post-op	6
15	Y	Dissecting vertebral	Coil	C	None	0
16	N	Dissecting fusiform PCA	Coil + onyx	C	None	0
17	Y	Dissecting blister ICA	Clip trapping	C	None	0