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ABSTRACT

BACKGROUND AND PURPOSE: The rate of PICA occlusion after flow-diverting stent placement for vertebral and vertebrobasilar artery aneurysms is not known. The purpose of this study is to determine the medium-term rate of PICA patency and risk factors for occlusion after such aneurysm treatment.

MATERIALS AND METHODS: Patients were identified who had vertebral or vertebrobasilar artery aneurysms and who were treated by placing a flow-diverting stent across the PICA ostium. Demographic and procedural factors associated with stent placement were recorded. Patency of the PICA was evaluated immediately after stent placement and on follow-up angiography.

RESULTS: Thirteen patients with vertebral or vertebrobasilar artery aneurysms were treated in the study period, of whom 4 presented with subarachnoid hemorrhage. The average number of devices that spanned the PICA ostium was 1.77 (range, 1–3), with no immediate PICA occlusions. There were no postoperative strokes in the treated PICA territory, although there was 1 contralateral PICA-territory stroke of unclear etiology without clinical sequelae. In 11 patients with follow-up angiography at a mean of 10.6 months (range, 0.67–27.9 months), the PICA patency rate remained 100%.

CONCLUSIONS: Flow-diverting stent placement across the PICA ostium in the treatment of vertebral and vertebrobasilar artery aneurysms may not result in immediate or midterm PICA occlusion.

ABBREVIATION: FDS = flow-diverting stent

The initial studies of safety and efficacy of flow-diverting stents (FDSs), such as the Pipeline Embolization Device (Covidien, Irvine, California), for the treatment of intracranial aneurysms primarily focused on anterior circulation aneurysms.[1] The application of an FDS in posterior circulation aneurysms remains controversial due to an increased risk of thrombotic and hemorrhagic complications.[2-4] The location of some vertebral and vertebrobasilar aneurysms in relation to the PICA often necessitates stent placement across the arterial ostium, theoretically risking PICA occlusion with resultant brain stem infarction. The immediate and midterm rate of branch occlusion of the PICA after FDS placement has not been described.

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MATERIALS AND METHODS

This study was approved by the institutional review board of St. Joseph's Hospital and Medical Center. Review of our prospective endovascular data base was performed, and all the patients with vertebral and vertebrobasilar artery aneurysms who were treated between May 2011 and May 2015 with an FDS in which one or more devices spanned the ostium of the PICA were identified. Patient demographics, aneurysm rupture status, the number of stent devices deployed, the presence of adjunctive aneurysm coiling, antiplatelet medication reactivity testing, and the postoperative stroke rate were recorded. Initial postprocedure and follow-up angiography images were reviewed to determine the immediate and midterm PICA patency rate after FDS placement.

All but one of the patients with unruptured aneurysms were pretreated with aspirin (325 mg/day) and clopidogrel (75 mg/day) for at least 3 days before the procedure. Patients with ruptured aneurysms were treated with a single 0.125 mg/kg intraprocedural bolus of intravenous or intra-arterial abciximab after stent placement instead of dual antiplatelet pretreatment. Platelet inhibition testing was used to determine patient response to aspirin and clopidogrel. All the patients

were maintained on antiplatelet therapy for 6 months after the index procedure, after which only aspirin (81 mg/day) was continued.

The technique of FDS deployment has been described previously.[5] All endovascular procedures were performed with the patient under general anesthesia, with neurophysiologic monitoring, and via transfemoral transarterial access. Intravenous heparin was administered to maintain an activated clotting time of at least 250 seconds. Multiple devices were placed at the discretion of the surgeon for optimal aneurysm coverage. In cases in which aneurysm coils were placed, a separate microcatheter was jailed within the aneurysm dome before FDS placement.

RESULTS

Thirteen patients (mean age, 61.3 ± 12.4 years) met inclusion criteria. The average aneurysm size was 9.3 ± 4.9 mm in maximal dimension, and 4 of 13 (30.8%) were ruptured at presentation. There were no instances of AICA-PICA complex. One of the 9 patients with an unruptured aneurysm refused clopidogrel pretreatment and only took aspirin 325 mg/day. Platelet inhibition testing results showed that no patients had aspirin resistance and that 3 patients had clopidogrel resistance. Two of these 3 patients were switched to prasugrel (10 mg/day), and 1 patient with a history of deep venous thrombosis was maintained on preoperative warfarin (5 mg/day).

In 6 patients (46%), the aneurysm involved the PICA origin (4 in whom the PICA origin arose from the neck of the aneurysm, and 2 in whom the PICA arose from the dome of the aneurysm); in the remaining 7 patients (54%), the PICA origin was either distinctly proximal or distal to the aneurysm. Between 1 and 3 FDS devices (mean, 1.77) were implanted. Two of 13 procedures (15.4%) included adjuvant aneurysm coiling; both were only partially coiled because both aneurysms incorporated the PICA origin into the aneurysm dome. There were no periprocedural neurologic complications.

A review of the angiography immediately after stent deployment demonstrated PICA patency in all 13 procedures. Two patients were lost to follow-up, and the remaining 11 patients underwent follow-up angiography (mean, 10.6 months; range, 0.67–27.9 months). There were no instances of PICA occlusion or stenosis on follow-up angiography. The rate of aneurysm obliteration at follow-up was 72.7% (8/11 patients), and there was 1 case (9.1%) of a patient with mild in-stent stenosis.

DISCUSSION

We showed that the rate of immediate and midterm patency of the PICA was high after FDS treatment of vertebral and vertebrobasilar artery aneurysms. There were no clinical sequelae from spanning the PICA ostium with one or more devices and no specific risk factors associated with PICA occlusion.

Branch occlusion after FDS placement is an uncommon occurrence. A large series of 178 aneurysms treated with FDSs found a 1.4% (2/140) rate of branch occlusion at follow-up, in both cases posterior communicating arteries.[6] Similarly, Moon et al[7] reported an ophthalmic artery occlusion rate of 3.5% (1/29) in a series of periophthalmic artery aneurysms treated by FDS that remained clinically silent. However, other researchers reported a higher occlusion rate. Puffer et al[8] studied 20 patients after FDS placement for internal carotid artery aneurysms and found that 15% of ophthalmic arteries had slow or absent flow immediately after FDS placement, with subsequent occlusion in 21% at follow-up angiography. No patients developed any clinical deficit from ophthalmologic occlusion. Another study, of 49 patients with 68 carotid aneurysms, found an overall branch occlusion rate of 4.4% (4% of ophthalmic and 7.1% of posterior communicating arteries) without clinical sequelae at follow-up angiography.[9] A study of 11 patients with 13 carotid aneurysms in which the posterior communicating artery ostium was covered by one or more FDSs found an occlusion rate of 27%, with an additional 18% with diminished flow.[10] Finally, 2 reports with a combined total of 43 anterior choroidal arteries spanned by at least 1 FDS in the treatment of carotid aneurysms documented 2 branch occlusions (4.7%) at follow-up, without clinical sequelae.[11,12] No study found a significant association between branch occlusion and the number of FDS devices placed across vessel ostia.

There are limited studies of posterior circulation aneurysms treated with FDSs, only one of which (Gascou et al[13]) specifically reported the patency of the PICA. This series of 59 patients with 66 aneurysms in various locations found a 3% overall occlusion rate and 16.2% branch vessel stenosis rate at follow-up. The FDS spanned the PICA ostium in 6 patients (9.1%); none of these PICAs were occluded on immediate or follow-up angiography, though stenosis was seen in 2 of 6 patients at the 12-month follow-up. In contrast, we did not observe any PICA stenosis in the 11 patients with follow-up angiography, though our average follow-up was only 10.6 months.

Neurologic deficit is rare after branch occlusion by FDS placement.[13-15] Two patients in the series from Gascou et al[13] had infarction after coverage of the middle cerebral artery perforators and the anterior division of the middle cerebral artery bifurcation, respectively. Three patients with basilar tip aneurysms (in which the FDS was placed from the P1 segment to the midbasilar artery) had brain stem perforator-related infarction among a series of 32 posterior circulation aneurysms treated by FDS.[15] Finally, a patient with a complex A1 segment aneurysm treated by FDS awoke from the procedure with perforator-related infarction.[14] Despite acute or subacute presentation of infarction, perforator occlusion was not observed during angiography at the time of FDS placement in any of the above complications.

The low rate of PICA occlusion after FDS placement is likely related to the small size of the FDS wire diameter (30 μm)[16] compared with the PICA diameter (mean, 1.23 mm; range, 0.5–2.5 mm).[17] The average diameter of the ophthalmic artery is reported to be between 1.75 and 2.9 mm,[18,19] but it carries a substantially higher reported rate of immediate and long-term stenosis or occlusion after FDS placement. The higher radius of curvature at the origin of the ophthalmic artery would be expected to increase, rather than reduce, stent porosity[16] compared with the relatively straight vertebral artery segment from which the PICA originates. Animal studies indicate a minimal but increased incidence of branch occlusion with lower stent porosity,[20] such as what might be found after FDS implantation across the PICA ostium and with multiple overlapping stents.[21] However, our study and others did not find an association between the number of devices and branch

occlusion. Animal studies indicate that the perfusion demand of tissue supplied by branch vessels that are covered by the FDS maintains branch vessel patency.[22] We hypothesized that the increased volume of tissue supplied by the PICA alone demands a higher flow rate from this artery at its ostium compared with the relatively small amount of tissue perfused by the ophthalmic artery, and the rich collateral arterial network in the orbit may, in addition, reduce the demand on the ophthalmic artery. However, further animal studies are required to confirm this theory, and caution should be exercised in the presence of aneurysms that involve an AICA-PICA complex, the thrombosis of which could cause significant neurologic morbidity.

CONCLUSIONS

In this small series, FDS placement across the PICA ostium in the treatment of vertebral and vertebrobasilar artery aneurysms did not result in immediate or midterm PICA occlusion.

Disclosures: Cameron McDougall—*UNRELATED*: *Consultancy*: Covidien, MicroVention Inc.

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