Endovascular Management for P2 Aneurysms of the Posterior Cerebral Artery

Experience on Proximal Occlusion of the P2 Segment

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Summary

This study evaluated the outcomes of endovascular management for P2-segment aneurysms. From 2003 to 2008, 14 consecutive patients with P2 aneurysms were treated endovascularly by proximal P2 segment occlusion at our institution. The aneurysms included 12 P2a and two P2p aneurysms. Presenting symptoms were caused by subarachnoid hemorrhage (SAH) in six patients, stroke in five, and isolated headaches in three. Mean follow-up was 14 months. Twelve aneurysms were treated with proximal P2 segment occlusion without parent artery revascularization. Twelve aneurysms were at the P2a and two aneurysms at the P2p. Two patients developed hemianopsia after the procedure and one recovered completely within six months follow-up with one still persistent at 22-month follow-up. Proximal parent vessel occlusion was a relatively safe, effective treatment for P2 aneurysms that posed low risk for early or delayed ischemia or infarction.

Introduction

Aneurysms of the posterior cerebral artery (PCA) account for 0.3 to 2.3% of all intracranial aneurysms¹. Most PCA aneurysms arise from P2 region (e.g. spanning from the posterior communicating artery (PComA) to the point at which the PCA enters the quadrigeminal cistern), including P2a, and P2p (divided

by the posterior aspect of the cerebral peduncle)¹⁻⁴. Clearly this is a subclass of very complicated aneurysms, in which endovascular treatment may have significant advantages over surgical treatment. The P2 segment is such a location. Terasaka et Al⁴ reported that 36% of the patients who underwent a surgical procedure in their series experienced a moderate or severe disability. If it is possible to treat an aneurysm in this location with proximal occlusion of the posterior cerebral artery, then such an approach may be preferable to an open surgical technique^{2,3,5}. Coil embolization of an aneurysm in this location may also make sense if the surgical difficulties are viewed as insurmountable⁶. There will certainly continue to be cases in which endovascular treatment is not the best option for an individual patient, i.e., if the patient cannot tolerate proximal P2 occlusion⁷. However, evaluation of the anastomotic collateral channels prior to a planned artery occlusion is not easily recognizable on routine subtraction angiography. The aim of this study was to retrospectively review our experience with 14 P2 aneurysms treated by proximal P2 occlusion.

Material and Methods

P2 segment

The P2 segment of the PCA was classified according to Krakenbuehl and Yasargil's classification⁸. The P2 segment extends from the

PCoM to the take-off of the major inferior posterior temporal trunk. The P2 segment is subdivided into P2a and P2p by the posterior aspect of the cerebral peduncle. P2 aneurysms were arbitrarily defined as aneurysms located at the P2a or P2p segment.

Patient population

Between 2003 and 2008, 14 consecutive patients presenting with aneurysms of the P2 segment treated by proximal coil occlusion of the parent vessel were reviewed retrospectively. There were three females and 11 males ranging in age from four to 56 years (mean age, 30.6 years). Aneurysms arose from the P2 as follows: 12 (85.7%) P2a, two (14.3%) P2p (Figure 1). Clinical presentation included isolated headaches in three patients (21.4%). In five patients (35.7%), the aneurysm caused symptoms of ischemia and compression of midbrain. Six patients (42.9%) presented with SAH. Clinical grading at admission in six patients with SAH, according to the Grade I–V scale of Hunt and Hess, revealed Grade I in four patients, Grade II in two patients. Of the 14 aneurysms, one was small, six were large (≥ 10 mm, < 25 mm), and seven were giant (≥ 25 mm).

Radiologic evaluation

All 14 patients underwent cerebral angiography to determine the exact location and configuration of the aneurysm. Computed tomography (CT) and, when available, magnetic resonance imaging (MRI) were used to determine the aneurysm size and the degree of intraluminal thrombosis. Four-vessel angiography was performed to assess the size, shape, configuration, and relationship of the aneurysm neck to the parent artery before the intervention and

the temporal branches of the MCA were evaluated for the potential ipsilateral flow from the anterior circulation to the involved PCA territory.

Treatment

All patients were treated under general anesthesia. Systemic heparinization was achieved during the procedures with heparin 5000U bolus followed by 1000U of heparin every hour. The intravascular procedures were performed in the neurointerventional room under general anesthesia with direct fluoroscopic guidance. The femoral artery was catheterized via the Seldinger technique.

After a 6.0 French sheath was inserted into the femoral artery, 70 mg/kg heparinization sulfate was administered, titrating the activated clotting time to two to three times baseline. Next, a 5.0 French guiding catheter was passed into the cervical vertebral artery, through which a microcatheter (Echelon 10, M.T.I-ev3, CA, USA/ SL-10, Boston Scientific, CA, USA) was passed in a coaxial fashion through the guiding catheter followed by selective catheterization of the artery with the aneurysm in each case. The tip of the catheter was placed in the aneurysm. Coils were selected on the basis of the size of the aneurysm and artery to be occluded. The smallest coil was 2x40 mm (Microvention, Tustin, CA, USA). Angiography was performed after coil placement to confirm occlusion of the aneurysm and the parent vessel. No tolerance test of occlusion was performed in any patient. Patients received anticoagulation therapy for 24 hours.

Follow-up

Eight patients were evaluated at mean 11-month follow-up (range, three months to four years) after treatment including angiography neurological examination. Clinical follow-up was obtained through a telephone interview. The mean duration of follow-up was 14 months (range, two months to four years). The outcomes of the 14 patients are presented in Table 1 according to their modified Rankin Scale (mRS)⁹.

Results

Clinical results

Fourteen aneurysms were dissecting aneurysms. Five patients presented with hemiparesis

Figure 1 The chart summarizes the location of aneurysms on the P2 in 14 patients: 12 (85.7%) P2a and two (14.3%) along the P2p segment. The frontopontine tract (FPT), corticospinal tract (CST) and parieto-temporal pontine tract (PPT) ranked on the sequence from anterior-medial to posterior-lateral in the cerebral peduncle. Corticospinal fibers to the face, arm, trunk and leg ranked on the sequence from anterior to posterior in the CST. This can explain why patients with P2a aneurysms presented with hemiparesis and palsy of the arm was worse than the leg.

caused by ischemic stroke and the palsy of the arm was worse than the leg. Two patients had hemianopsia postoperatively. In this series, we found no correlation between the size of P2 aneurysms and neurologic signs and symptoms. Arm palsy persisted in two patients, despite a documented shrinkage in aneurysm size and alleviation of the mass effect in one patient and a small aneurysm in other patient.

Resolution of signs and symptoms

Table 1 lists the symptomatology in the 14 patients treated by intravascular coil occlusion for aneurysms of the P2 and shows the number of patients whose symptoms improved after treatment. Hemiparesis, hemihypoesthesia, memory loss and CNIII (oculomotor nerve) palsy were demonstrated in seven patients. After treatment, six of the seven patients had improved movement function. One patient who

had memory and CNIII involvement on presentation improved function of this nerve and memory after treatment.

Complications

Two patients developed hemianopsia after intravascular parent vessel occlusion treatment. One responded to volume expansion and anticoagulation followed by a short course of antiplatelet treatment with no further evidence of hemianopsia. In this series, the overall complication rate was 7.1% (1/14); one patient developed permanent hemianopsia as a result of ischemia.

Illustrative cases

Patient 12

A 46-year-old female patient who presented with acute headaches and left hemiparesis un-

Table 1 Clinical parameters of patients with 14 P2 aneurysms treated with proximal occlusion.

Patient No.	Age Sex	Sites, sizes of aneurysms	Presentation	Clinical outcome (mRS)	Follow-up period (months)
1	49/M	P2a, R, large	Headaches, hemiparesis(L)	2, hemianopsia clumsy of left hand	22
2	43/M	P2a, L, large	Headaches, hemihypoesthesia(R)	0	8
3	48/M	P2a, R, giant	SAH, memory deficit, CNIII palsy(R)	0	5
4	31/M	P2a, L, giant	SAH	0	5
5	4/M	P2a, R, giant	Headaches	0	36
6	37/F	P2a, L, small	SAH, Hemiparesis(R)	0	4
7	30/M	P2a, L, large	SAH	0	6
8	5/M	P2a, L, large	SAH	0	10
9	16/M	P2a, L, large	Headaches	0	3
10	37/M	P2p, L, giant	SAH,	0	36
11	25/F	P2a, R, giant	Hemiparesis(L)	0	6
12	46/F	P2p, R, large	Headaches, Hemiparesis(L)	0	6
13	47/M	P2a, R, giant	Headaches Hemiparesis(L)	0	2
14	10/M	P2a, L, giant	Headaches	0	48

SAH: subarachnoid hemorrhage; L: left; R: right; CNIII: oculomotor nerve; small: <10 mm; large: ≥10mm, <25 mm; giant: ≥25 mm.

derwent MRI, which suggested an aneurysm on the P2 in the right ambient cistern (not shown). No subarachnoid hemorrhage was detected. Subsequent angiography revealed a fusiform aneurysm on the left P2p segment of the PCA (Figure 2A). Five detachable coils were used to occluded the aneurysm and P2 segment (Figure 2B,C). After the procedure, visual field testing demonstrated right hemianopsia (Figure 2D). The patient was treated conservatively with volume expansion and anticoagulation followed by a short course of antiplatelet treatment and demonstrated intact neurological function at six month follow-up.

Patient 11

A 25-year-old female patient who had acute left hemiparesis underwent CT and MRI,

which disclosed an abnormal intracranial mass. The mass had a diameter of 30 mm, and it compressed the right cerebral peduncle (Figure 3A). Cerebral angiography revealed a fusiform aneurysm at the right P2a (Figure 3B). The aneurysm was treated with parent vessel occlusion (Figure 3C,D). At six month follow-up the patient showed no neurological deficits.

Discussion

PCA aneurysms occur more frequently in young patients and there is a higher incidence of large and giant aneurysms, which distinguish them from other aneurysms¹⁰⁻¹³. The most common PCA aneurysm is the P2 aneurysm^{2,12,17}. Our patients account for 51.9% PCA aneurysms in the same period. Aneurysms of the P2

Figure 3 A) Axial MRI T1-weighted scan shows a large mass with a “bull’s eye” in the right ambient cistern, which compressed the right cerebral peduncle. B) Left vertebral angiogram (anteroposterior view) reveals a fusiform aneurysm arising from the right P2a. C) Postoperative left vertebral angiogram (anteroposterior view) demonstrates no residual aneurysm. The main trunk of the PCA was occluded. D) Postoperative right carotid angiogram (lateral view) shows the retrograde filling of the cortical branches of the PCA.

segment are an important cause of stroke and headaches in younger patients^{4,14,15}. A complaint of headache prompted diagnostic inquiry in three of our 14 patients, each of whom was

found to have an unruptured large or giant aneurysm.

A major cause of morbidity and mortality associated with treatment of aneurysms of the

P2 is ipsilateral hemianopsia^{1,2,4,5,16}. This risk largely depends on the adequacy of the ipsilateral circulation. In our study no occlusion test of the P2 was used to predict the ability of a patient to tolerate permanent occlusion for treatment of a P2 aneurysm. In the PCA territory, there are rich ipsilateral vascular networks including collateral anastomosis between the the inferior temporal branches of the PCA and the superior temporal branches of the MCA, lateral posterior choroidal and the anterior counterpar, the splenial artery and the posterior pericallosal artery, the long circumflex arteries and the superior cerebellar arteries at the level of the quadrigeminal plate. In general, the MCA and the PCA are embryologically similar and the MCA is a branch from the ACA and the PCA is a branch from the ICA¹. The most important anastomosis is between the temporal branches of the PCA and MCA. We do have the option of MCA to determine whether patients require revascularization or not. If the temporal branches of MCA could cover the PCA territory on preoperative angiogram, the P2 can be occluded.

Aneurysms of the P2 around the midbrain affect neurological function by compressing or by causing ischemia of the upper brain stem⁴. Recent reports suggest that the risk for ipsilateral ischemic deficits after P2 occlusion for treatment of aneurysms is 0 to 75%^{2,5,17,18,19}. Ischemia associated with P2 occlusion may be secondary to decreased blood flow in the PCA distribution³. In our series, the immediate ischemic morbidity after P2 occlusion was 14.2% and permanent ischemic complication after intravascular occlusion of the P2 was 7.1%.

Treatment options for aneurysms of the P2

include surgical treatment, and, recently, endovascular parent vessel occlusion. The surgical approach of the P2 aneurysms is technically difficult and controversial owing to the deep sites and intimate relationship of its perforating branches and the cranial nerves, upper brain stem and optic radiation¹⁵. Ferrante et Al.¹⁸ reported that surgical procedures, such as clipping, trapping, and proximal ligation, had no influence on the patient's outcome, owing to the rich collateral circulation of the parieto-occipital region, whereas preoperative clinical grade was the only factor that influenced prognosis. Overall morbidity rate reported by Terasaka et Al was 36%⁴. Test injection with Amytal was not performed in our case because we believe that Amytal testing is overly predictive of deficits, owing its deep penetration into all of the peripheral vessels^{2,3}.

Conclusions

In this series of P2 aneurysms treated by proximal P2 occlusion, we report a permanent ischemic morbidity rate of 7.1%. These results compare favorably with results of surgical treatment. This study provides a clear understanding of intravascular parent vessel occlusion for treating aneurysms of the P2 segment. Evaluation of MCA before treatment may provide a means of determining tolerance for permanent P2 occlusion. For aneurysms of the P2, intravascular parent vessel occlusion is the safest and most effective form of treatment. Finally, the results reported in this article suggest an opportunity to study endovascular parent artery occlusion prospectively for the management of these difficult posteriorly located lesions.

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