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Posterior Cerebral Artery Aneurysm : Surgical Result of 11 Patients

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Objective : Eleven patients treated with posterior cerebral artery(PCA) aneurysm during 6.3-years period are retrospectively reviewed to determine treatment outcome.

Methods : Eleven patients with PCA aneurysm were treated from January 1998 to May 2004. Their medical records and radiologic studies were reviewed retrospectively. The records of these patients were analysed with particular reference to their demographic details, mode of presentation, and treatment outcome.

Results : Of the 11 patients, 8 patients presented with symptoms related aneurysmal bleeding. Three patients had unruptured PCA aneurysms. Open or endovascular surgery was performed in 9 patients; None of these patients exhibited a third nerve palsy, visual field deficit, or hemiparesis at the time of presentation. Postoperatively, 2 made a good recovery, 2 had a moderate disability because of cerebral infarction after surgery, and 5 had a severe disability because of cerebral infarction after surgery. Of 2 conservatively treated patients, 1 was doing well but the other died as a result of brain swelling.

Conclusion : The treatment of the PCA aneurysms is difficult regardless of the aneurysmal size, site, and treatment modality. All reasonable treatment to reduce the risk of associated morbidity should be considered.

KEY WORDS : Posterior cerebral artery · Treatment outcome · Aneurysm.

Introduction

In comparison to other locations of aneurysm, posterior cerebral artery(PCA) aneurysms are a rare occurrence, accounting for about 0.7~2.3% of all intracranial aneurysms[6,12,13,17,18]. PCA aneurysms differ from those in other sites with regard to their clinical behavior and in certain aspects of surgical technique and prognosis. In this study, we described our experiences of the treatment of 11 cases of PCA aneurysms, and operative approaches and procedures were discussed in relation to the anatomy of PCA aneurysms.

Materials and Methods

Incidence, age, sex, and clinical status

Between January 1998 and May 2004, 1324 intracranial aneurysms were treated in our hospital. Of these, 11 patients (0.83%) affected the PCA. The male/female ratio was 4 : 7 and the mean age was 56 years (range 31~73 years). The records of these patients were analysed with particular reference to their demographic details, mode of presentation, and treatment outcome (Table 1).

Diagnosis and location

Aneurysms were classified as saccular or fusiform according to their appearance on angiographic studies. Location was classified according to the description by Zeal, et al.[23], as four segments of the PCA. Among 11 patients, 8 patients had solitary aneurysm only. And the rest of 3 patients had multiple vascular lesions; Case 8 had a ruptured left P_2/P_3 junction aneurysm in addition to a unruptured basilar top aneurysm. Case 10 with a ruptured left P_1 segment aneurysm also had the unruptured aneurysm in the middle cerebral artery. Case 9 had a ruptured right P_3 aneurysm associated with an unruptured arteriovenous malformation(AVM) in the right occipital lobe.

Eight patients presented with symptoms of subarachnoid hemorrhage(SAH), confirmed by brain computed tomography

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Table 1. Characteristics of 11 patients with PCA aneurysms

Case	Age	Sex	Present	H-H Grade	Aneurysm			Treatment	Postoperative state	GOS at discharge
					Site	Size(mm)	Type			
1	67	F	SAH	2	P_1/P_2	9.3	Fusiform	Pteri +Clip	Hemiparesis	3
2	44	M	SAH	2	P_1/P_2	6	Saccular	Sub +Clip	CN III palsy	5
3	38	M	HA	0	P_1	40	Fusiform	Pteri +Clip	Hemiparesis	3
4	71	F	SAH	2	P_1	2	Saccular	Pteri +Clip	Hemiparesis	4
5	30	F	SAH	2	P_2	22	Saccular	Orbito +Trap	Hemiparesis	3
6	31	M	HA	0	P_3	12	Saccular	Embolization	Doing well	5
7	61	F	SAH	3	P_2	50	Fusiform	Embolization	Hemiparesis	3
8	73	F	SAH	2	P_2/P_3	8	Saccular	Embolization	Hemiparesis	3
9	55	F	SAH	2	P_3	10	Saccular	Embolization	Hemiparesis	4
10	69	M	SAH	4	P_1	18	Saccular	Conservative	-	1
11	34	F	HA	0	P_1/P_2	10	Saccular	Conservative	-	5

Clip : clipping, CN : cranial nerve, GOS : Glasgow outcome scale, HA : headache, H-H : Hunt-Hess, Orbito : orbitozygomatic, PCA : posterior cerebral artery, Present : presentation, Pteri : pterional, SAH : subarachnoid hemorrhage, Sub : subtemporal, Trap : trapping

(CT) scan, while the remaining 3 cases with unruptured aneurysm presented with only headache. Cerebral angiography identified PCA aneurysms. Neurological status was evaluated on admission according to the scale of Hunt and Hess[5]. Postoperative status was evaluated according to the Glasgow outcome scale(GOS). The size of the aneurysm was small (<12mm) in 7 cases, large (12~25mm) in 2 cases and giant (>25mm) in 2 cases.

Results

Open surgery group

Five patients were managed with open surgery (2 men, 3 women; aged 30~71 years; 4 presented with SAH). None of these patients exhibited a third nerve palsy, visual field deficit, or hemiparesis at the time of presentation. The aneurysms included 3 saccular and 2 fusiform lesions. The 3 saccular aneurysms occurred on the P_1 segment, at the P_1/P_2 junction, and on the P_2 segment. The 2 fusiform aneurysms were located on the P_1 segement and at the P_1/P_2 junction.

The surgical approaches were subtemporal approach (1 P_1/P_2), pterional approach (2 P_1, 1 P_1/P_2), and orbitozygomatic approach (1 P_2). Surgical procedures included direct clipping in 4 cases, trapping in 1 case (orbitozygomatic approach).

A 44-year-old man (case 2) was admitted to our hospital with sudden onset severe headache. CT scans demonstrated a SAH. A saccular aneurysm at the P_1/P_2 junction of the left PCA was observed on the angiogram. It measured nearly 6mm. It was approached via the subtemporal route, and it was clipped. Postoperatively, the patient experienced transient left third nerve palsy, but no neurological deficit was found 1 year later (Fig. 1).

Cases 1,3, and 4 were managed with the pterional approach (2 P_1, 1 P_1/P_2). All of these patients suffered from contralateral hemiparesis postoperatively, and case 4 was suffered from ipsilateral third nerve palsy.

A 30-year-old woman (case 5) was admitted with SAH. She was treated with the orbitozygomatic approach for wide exposure of the aneurysm. Angiogram revealed a 22mm-sized saccular aneurysm in the P_2 segment of the left PCA. Trapping with clips was performed via the orbitozygomatic approach. The patient deteriorated postoperatively, developing a right hemiparesis because of cerebral infartion. However, when assessed 4 year later, the patient had made a good recovery although she had walked with single cane (Fig. 2).

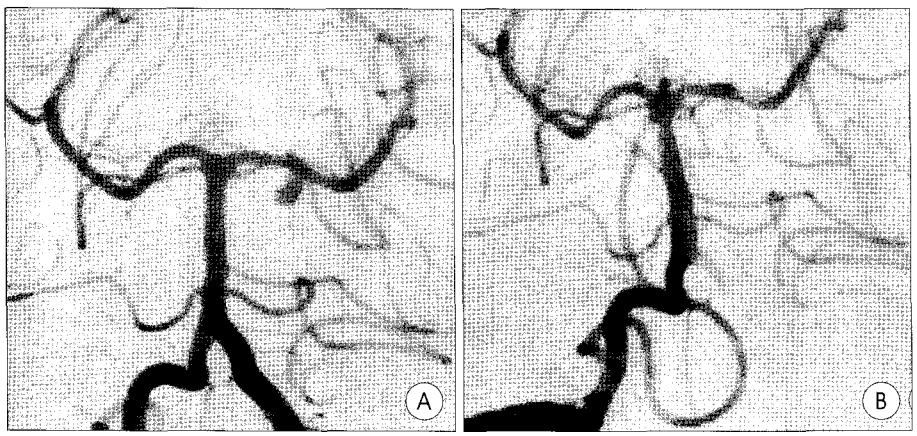

Fig. 1. A : An angiogram (anteroposterior view) shows a saccular aneurysm at the P_1/P_2 junction of the left posterior cerebral artery. B : An angiogram demonstrating that clipping resulted in complete obliteration of the aneurysm.

Endovascular surgery group

Among patients encountered after 2001, four patients with PCA aneurysm underwent endovascular surgery. Until 2001, only open

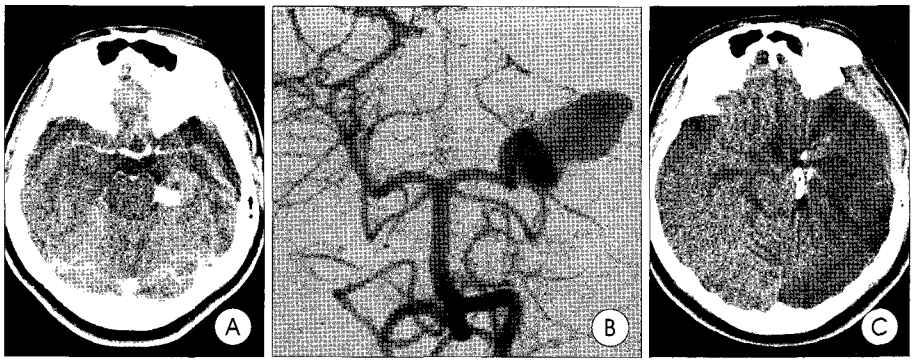

Fig. 2. A : A preoperative contrast-enhanced computed tomographic scan shows a high-density lesion in the left ambient cistern. B : A angiogram (anteroposterior view) shows an aneurysm in the P_2 segment of the left posterior cerebral artery (PCA). C : postoperative computed tomograhpic scan demonstrating a low -density area in the distribution of the left PCA.

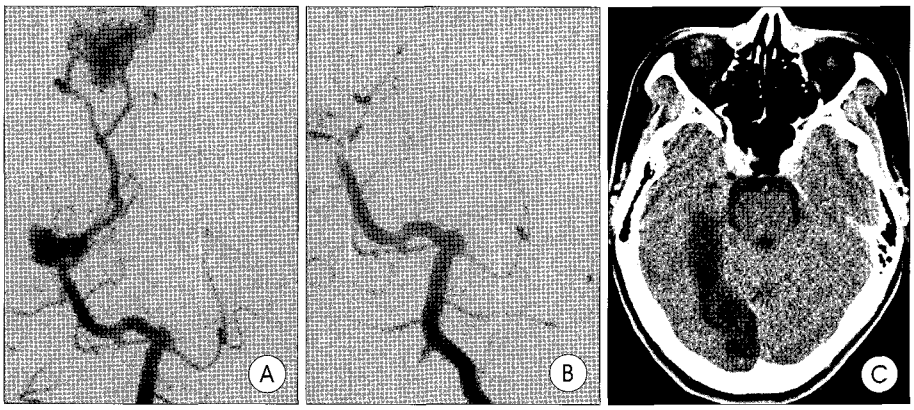

Fig. 3. A : An angiogram (anteroposterior view) shows an aneurysm on the right P_3 segment with arteriovenous malformation in the right occipital lobe. B : An angiogram demonstrating that detachable coil embolization resulting in no visualization of the left posterior cerebral artery (PCA) distal to the P_3 segment. C : postoperative computed tomograhpic scan demonstrating a low -density area in the distribution of the right PCA.

surgery was performed to treat PCA aneurysm in our hospital. Four patients were managed with endovascular surgery using Guglielmi detachable coils (GDCs) (1 man, 3 women; aged 31~73 years; 3 presented with SAH).

A 31-year-old man (case 6) was admitted for the treatment of a unruptured saccular aneurysm (12mm) in the left P_3 segment. The aneurysm was embolized with GDCs. Angiogram demonstrated that detachable coil embolization resulted in no visualization of the left PCA distal to the P_3 segment. But he had no neurologic deficit after embolization.

A 73-year-old woman who had a ruptured aneurysm at the left P_2/P_3 junction with an unruptured basilar top aneurysm (case 8) was treated with embolization of left PCA aneurysm. The PCA aneurysm was embolized almost completely with GDCs and postoperatively, the blood flow of both PCA was intact on angiogram. But, she suffered from right hemiparesis and aphasia.

A 55-year-old woman who had ruptured aneurysm on the right P_3 segment with arteriovenous malformation(AVM) in right occipital lobe (case 9), suffered from left hemiparesis postoperatively (Fig. 3). Angiogram demonstrated no visualization of the left PCA distal to the P3 segment.

Treatment outcome

Of the 9 surgically treated patients, 2 made a good recovery, 2 had a moderate disability because of cerebral infarction after surgery, and 5 had a severe disability because of cerebral infarction after surgery.

Discussion

PCA aneurysms present some clinical characteristics distinguishing them from aneurysms occuring at other anatomical locations. The incidence of PCA aneurysms is rare as comfirmed by previous reports[5,12,17,22]. In our study, the incidence was 0.83% (11/1324). PCA aneurysms more frequently affect young patients[1,8]. In our study, the mean age was 56 years and average age of patients was similar to that of patients with aneurysms at other sites[1,6,8,9]. The most common shape of aneurysm is saccular[11,16]. 7 (63%) of 11 PCA aneurysms in our study were saccular type. Other characteristic of PCA aneurysms is the high incidence of giant aneurysms[4,21]. In other general series of intracranial aneurysms, it varied from about 3% to 5%[3,13]. In our study, the incidence of giant aneurysm was 18% (2/11). They may present with SAH. In our study, the most common mode of presentation was SAH (8/11, 72%), which is similar to other reported series[8,9,15]. Three patients manifested coexisting vascular lesions; 1 patient had an occipital AVM, and 2 had multiple intracranial aneurysms.

The PCA is divided into four segments descriptively as it courses around the midbrain[23]. The P_1 segment arises from the basilar bifurcation to the junction with the posterior communicating artery; the P_2 segment is from the posterior communicating artery to the level of the dorsum of the midbrain; the P_3 segment is from the quadrigeminal cistern to anterior limit of the calcarine fissure; and the P_4 segment is the termination of the artery within the calcarine fissure. As comfirmed by other reported series[5,6,16,17,22], the majority of

aneurysms arise along the P_1 and P_1/P_2 junction. In our study, 6 (54%) of 11 PCA aneurysms were found on the segment P_1 or at the P_1/P_2 junction. In the series by Drake, et al.[7], 71 (57%) of 125 lesions were located in these locations.

The surgical approaches of the PCA aneurysm are variable according to the location of the aneurysms. Aneurysms of the initial segment (P_1 and P_1/P_2 junction) of the PCA can be approached by means of the surgical approach used for basilar top aneurysms[16].

The P_2 segment somehow extends to the posterior part of the ambient cistern and lies in the depths of the ambient cistern hidden by the parahippocampal gyrus[19]. Although the proper approach to aneurysms located on the P_2 segment remains controversial, they should be exposed via the pterional, subtemporal, or combined pterional-subtemporal approach. The approach to that area via the pterional transsylvian and the subtemporal route usually requires greater degree of retraction over the temporal lobe that consequently increases the potential for damage to the vein of Labbe and damage to the cranial nerve III and IV[14,19].

The P_3 segment is located in the quadrigeminal cistern and adjacent to the junction of the hippocampal and cingulate gyri. Through the occipital interhemispheric approach, one can easily reach the most medial portion of the PCA inside the quadrigeminal cistern[21].

We treated aneurysms on the P_1 segment, at the P_1/P_2 junction, and on P_2 segment through a pterional, subtemporal, and orbitozygomatic approach, ipsilateral to the lesion. The pterional approach was favored by Yasargil[21] whereas Drake, et al.[4] used the subtemporal approach. The primary advantages of the pterional approach[21] which we have used in most cases are early proximal control with isolation of the basilar artery, posterior commucating artery, and P_1 segment origin, and good visualization of the contralateral PCA to allow temporary trapping. But in the restricted space that it offers, access to the distal PCA aneurysms is severely limited.

The subtemporal approach[4] may offer improved visualization of the critical thalamoperforating and peduncular perforating vessels originating from the posterior aspect of the PCA that must be preserved in all cases. However, considerable retraction of the temporal lobe may be required, especially to reach aneurysms of P_2-P_3 segments, and this could be complicated by postoperative temporal lobe swelling and damage to the oculomotor and trochlear nerves[14].

The advantages of the orbitozygomatic approach are a wide exposure, flexibility of access, and minimal retraction[9]. Easier access to the interpeduncular and perimesencephalic cisterns is then gained by an extended decompression of the floor of the middle fossa. When the dura is opened, a good view of the free edge of the tentorium is obtained. This view is increased further by splitting the sylvian fissure and thus allowing the temporal lobe to fall backwards with minimal retraction. This measure provides ready access to the P_1, P_2, and P_3 segments of the PCA. So the possibility of clipping of the aneurysm and sparing of the parent artery are increased.

Compared with open surgery, the endovascular treatment of these aneurysms is relatively safe and effective with low mortalily and morbidity[20]. Endovascular treatment is not associated with manipulation of the surrounding tissues. Therefore, the risks of brain infarction due to retraction or removal are theoretically reduced. However, specific thromboembolic events are related to endovascular navigation[10]. Endovascular treatment obliterates the aneurysm or parent artery with GDCs or balloon. Saccular PCA aneurysms can be treated effectively, by use of GDCs, to obliterate the aneurysm yet preserve the parent artery[2]. In large and giant fusiform serpentine aneurysms and true fusiform aneurysms, the combined occlusion of the sac and parent vessel appears to be the only option possible by endovascular means. For large and giant saccular P_2 segment aneurysms, occlusion of the aneurysmal sac and neck may be difficult, especially in wide-necked aneurysms[10]. We treated a giant fusiform aneurysm at the left P_2 segment (case 7) with embolization of the aneurysm. The aneurysm was occluded incompletely with GDCs and postoperatively, the blood flow of left PCA distal to the aneurysm was faint on angiogram. And the patient suffered from right hemiparesis.

In cases in whom the parent artery was occluded, there was visual field defect (10~12%) without other severe neuroligic deficit[2]. The low incidence of severe neurologic deficit coplicating parent artery occlusion is related to the rich anastomotic collaterals that exist between the territory of the PCA and that of other arteries[8].

Although well-developed collateral vascular pathways supply the distal PCA territory after its occlusion, there were contralateral hemiparesis after occlusion of the parent vessel and aneurysm in our study.

In the series presented by Hamada et al[11], of the 19 surgically (open or endovascular surgery) treated patients, 14 (73%) made a good recovery and 2 had moderate disability because of angiospasm or infarction after aneurysmal trapping. One patient survived with a severe disability caused by angiospasm and cerebral contusion, and two patients died because of severe angiospasm. In 2000, Terasaki et al[19] reported the surgical approaches for the treatment of aneurysms on the P_2 segment of the posterior cerebral artery. Open surgery was performed in 14 of the 18 patients, nine patients (64.3%) achieved a good recovery. Two patients had moderate disability with slight hemiparesis. In these 2 patients, who underwent procedures via the subtemporal approach, local brain swelling occurred

postoperatively, probably caused by venous congestion. Two patients remained severely disabled. In our study, 9 patients were treated surgically, 2 (22%) made a good recovery, 2 had a moderate disability because of cerebral infarction after surgery, and 5 had a severe disability because of cerebral infarction after surgery.

The proximal saccular aneurysms were associated with a third nerve paresis and contralateral hemiparesis. This clinical syndrome might be anticipated, for aneurysms of the first part of the PCA have an intimate relation to the cerebral peduncle and to the thired nerve as it emerges between the posterior cerebral and superior cerebellar arteries[4]. In our study, of the 9 surgically treated patients, 7 had contralateal hemiparesis, and 2 had third nerve paresis.

Conclusion

Aneurysms of the PCA are interesting for reasons that include their relative rarity and the variety of approaches that may be used for their successful treatment. Although patients can be treated without causing new neurological deficits or other morbidity, many patients with these lesions are left with some degree of dysfunction caused by the complications associated with treatment. In our study, the treatment of the PCA aneurysms was difficult regardless of the aneurysmal size, site, and treatment modality. So, all reasonable treatment to reduce the risk of associated morbidity should be considered. And we will try to experience more cases and to improve treatment outcome.

References

1. Chang HS, Fukushima T, Takakura K, Shimizu T : Aneurysm of the posterior cerebral artery : report of ten cases. **Neurosurgery 19 :** 1006-1011, 1986
2. Ciceri EF, Klucznik RP, Grossman RG, Rose JE, Mawad ME : Aneurysms of the posterior cerebral artery : classification and endovascular treatment. **AJNR Am J Neuroradiol 22 :** 27-34, 2001
3. Drake CG : Giant intracranial aneurysms : Experience with surgical treatment in 174 patients. **Clin Neurosurg 26 :** 12-95, 1979
4. Drake CG : The treatment of aneurysms of the posterior circulation. **Clin Neurosurg 26 :** 96-144, 1979
5. Drake CG : Treatment of aneurysms of the posterior cranial fossa. **Prog Neurol Surg 9 :** 122-194, 1979
6. Drake CG, Amacher AL : Aneurysms of the posterior cerebral artery. **J Neurosurg 30 :** 468-474, 1969
7. Drake CG, Peerless SJ, Hernesniemi JA : **Surgery of Vertebrobasilar Aneurysms,** New York : Springer-Verlag, 1996, pp 221-248
8. Ferrante L, Acqui M, Trillo G, Lunardi P, Fortuna A : Aneurysms of the posterior cerebral artery : do they present specific characteristics? **Acta Neurochir (Wien) 138 :** 840-852, 1996
9. Gerber CJ, Neil-Dwyer G, Evans BT : An alternative surgical approach to aneurysms of the posterior cerebral artery. **Neurosurgery 32 :** 928-931, 1993
10. Hallacq P, Piotin M, Moret J : Endovascular occlusion of the posterior cerebral artery for the treatment of P2 segment aneurysms : retrospective review of a 10-year series. **AJNR Am J Neuroradiol 23 :** 1128-1136, 2002
11. Hamada J, Morioka M, Yano S, Todaka T, Kai Y, Kuratsu J : Clinical features of aneurysms of the posterior cerebral artery : a 15-year experience with 21 cases. **Neurosurgery 56 :** 662-670, 2005
12. Locksley HB : Report of cooperative study of intracranial aneurysms and subarachnoid hemorrhage. Section V, part II. Natural history of subarachnoid hemorrahage, intracanial aneurysms and arteriovenous malformations based on 6368 cases in the cooperative study. **J Neurosurg 25 :** 321-368, 1966
13. Morly TP, Barr HWK : Giant intracranial aneurysms : dianosis, course and management. **Clin Neurosurg 16 :** 73-94, 1968
14. Neil-Dwyer G, Sharr M, Haskell R, Currie D, Hosseini M : Zygomaticotemporal approach to the basis cranii and basilar artery. **Neurosurgery 23 :** 20-22, 1988
15. Pia HW, Fontana H : Aneurysms of the posterior cerebral artery. Locations and clinical pictures. **Acta Neurochir (Wien) 38 :** 13-35, 1977
16. Sakata S, Fujii K, Matsushima T, Fujiwara S, Fukui M, Matsubara T, et al : Aneurysm of the posterior cerebral artery : report of eleven cases -surgical approaches and procedures. **Neurosurgery 32 :** 163-167, 1993
17. Sugita K : Aneurysms of the posterior circle of willis in Sugita K : **Microsurgical atlas,** Berlin : Springer-Verlag, 1988, pp62-134
18. Suzuki J, Hori S, Sakurai Y : Intracranial aneurysms in the neurosurgical clinics in the Japan. **J Neurosurg 35 :** 34-39, 1971
19. Terasaki S, Sawamura Y, Kamiyama H, Fukushima T : Surgical approaches for the treatment of aneurysms on the P2 segment of the posterior cerebral artery. **Neurosurgery 47 :** 359-366, 2000
20. Yang JW, You Sh, Hong SC, Kim JS, Roh HG, Byun HS : Experience of endovascular treatment of distal posterior cerebral artery aneurysms. **J Korean Neurosurg Soc 34 :** 428-432, 2003
21. Yasargil MG : **Microneurosurgery.** Stuttgart : Thieme, 1984, vol 2, pp 260-269
22. Yasargil MG, Antic J, Laciga R, Jain KK, Hodoshi RM, Smith RD : Microsurgical approach to aneurysms of the basilar bifurcation. **Surg Neurol 6 :** 83-91, 1976
23. Zeal AA, Rhoton AL : Microsurgical anatomy of the posterior cerebral artery. **J Neurosurg 48 :** 534-559, 1978

Commentary

The authors retrospectively reviewed the results of 11 patients with posterior cerebral artery(PCA) aneurysms. They described the clinical outcome after surgical or endovascular and the difficulties of treatment. The most common complications of their series were hemiparesis due to the cerebral infarction. So, not only the complete obliteration of aneurysm, but also the preservation of patency of parent vessel is necessary to improve the clinical outcome. Sometimes, cerebral revascularization surgery should be added to the treatment. Avoidance of brain retraction injury and preservation of major venous system are also important points.

The incidence of PCA aneurysm is low, but it has specific clinical characteristics. It is characterized by high frequency of non-saccular shape, large or giant size with mass effect, multiple aneurysms, young age at onset, and abundant collateral circulation of the parent artery. Taylor et al insisted that the treatment should be determined by the anatomical location and size of the aneurysm and the presence of underlying disease and neurological deficits[2].

The management strategies of the PCA aneurysm in our institute are as follows : Surgical treatment is necessary for large or giant aneurysm of the distal PCA to decompress midbrain. Wrapping and clipping technique are useful for treatment

of fusiform aneurysm. Intra-aneurysmal endovascular coiling would be useful for the proximal PCA aneurysm to avoid surgical injury of the P1 perforator or occulomotor nerve[1].

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References

1. Lee JW, Lee KC, Kim DI : Specific characteristics and management strategies of posterior cerebral artery aneurysms. **Cerebrovas Dis 4 :** 129-134, 2002
2. Taylor CL, Kopitnik TA, Samson DS, Purdy PD : Treatment and outcome in 30 patients with posterior cerebral artery aneurysms. **J Neurosurg 99 :** 15-22, 2003