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Clinical Article

Aneurysm of the Posterior Inferior Cerebellar Artery : Clinical Features and Surgical Results

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Objective : Aneurysms arising from the posterior inferior cerebellar artery(PICA) are uncommon. We review literature on that and surgical results on aneurysmal treatment by choice of surgical approach.

Methods : On the basis of radiologic findings & charts, we review retrospectively the surgical results of 12 cases from Mar 1999 to Dec 2003.

Results : The mean age of the 12 patients was 55.8(ranged from 36 to 71) and female was predominant (female:male = 8:4). Locations of PICA aneurysms revealed variously(vertebral artery - PICA junction : 8, lateral medullary segment : 2, PICA - anterior inferior cerebellar artery common trunk : 1, telovelomedullary : 1). Surgical approaches & treatments were attempted in 11 cases and embolization was done in 1 case(Far lateral transcondylar or supracondylar approach & clipping : 9, Far lateral transcondylar or supracondylar approach and trapping : 2, suboccipital approach & clipping : 1). The surgical result were 8 of 12 patients were good outcome, 1 of 12 was severely disabled and 3 of 12 were died.

Conclusion : First, we choose surgical approach by the laterality of aneurysms and surgical or interventional treatment is attempted as soon as possible. The PICA aneurysm is regarded as having a relatively good surgical outcome without drilling of the posterior arch of the atlas.

KEY WORDS : Aneurysm · Posterior inferior cerebellar artery · Outcome.

Introduction

Aneurysms arising from the posterior inferior cerebellar artery(PICA) are rare representing approximately 0.49 ~ 3% of intracranial aneurysms[16]. The treatment outcomes and surgical results of these aneurysms are relatively poor compared to anterior circulation aneurysms in the neurosurgical literature, but advances in anatomical studies and skull base technique make it possible to improve the surgical results and treatment outcomes[7,9,10,15,21]. In this article, we review retrospectively our surgical experiences and their results with 12 PICA aneurysms treated from March 1999 to December 2003.

Materials and Methods

All patients who were treated with the diagnosis of PICA aneurysm had their charts retrospectively reviewed for the period of March 1999 to December 2003. Data was included concerning the patient's age, sex, Hunt and Hess grade, Fisher grade, associated lesions, characteristics of imaging studies. treatment modalities(surgical clipping, trapping or endovascular coiling), postoperative complications and final outcomes (Table 1).

Surgical procedure

We routinely use the far lateral approach, the surgical technique described by Rhoton[24] except for the scalp incision in which he described three stages of approach, muscular stage, extradural stage and intradural stage. We usually placed the patient in the Park bench position and incised scalp in a C-shape or curvilinearly. The key step of muscular stage is identifying the vertebral artery in the suboccipital triangle which is limited by rectus capitis posterior major muscle, superior and inferior oblique muscles. We removed at least half of the posterior arch of the atlas in the first few cases, but it was not routinely necessary to remove the atlas. The removal of the atlas makes it easy to mobilize the extracranial vertebral artery but in case of a PICA aneurysm it is not necessary to mobilize the vertebral artery. After that, we just removed the suboccipital bone and the occipital condyle. We stopped drilling the condyle when the cortical bone or dura covering hypoglossal canal was exposed (Fig. 1).

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Table 1. Clinical features of 12 patients with posterior-inferior cerebellar artery aneurysms

Case No.	Age/ Sex	Presentation	WFNS	Aneurysm		Combined lesion & laterality	Fis-cher	PICA aneurysm treatment	Outcome
				Location	Patholo-gical Type				
1	60/M	SAH	5	VA-PICA jct.	fusiform	Left	III	GDC	expired
2	71/F	SAH	2	VA-PICA jct.	saccular	Left	II	FLTC & clipping	GR
3	64/F	SAH	2	common AICA & PICA	fusiform	Right	II	FLTC & trapping	Rt. 6th. N palsy
4	49/F	SAH	4	VA-PICA jct.	saccular	Left	III	FLTC & trapping	Lt. 6th & 7th n. palsy & hydrocephalus
5	65/M	SAH,IVH, hydrcephalus	2	VA-PICA jct.	saccular	Right	IV	FLTC & clipping	no defict
6	51/F	SAH	4	VA-PICA jct.	saccular	Right	III	FLTC & clipping	expired
7	38/M	IVH	4	lateral medullary	saccular	Left	IV	FLTC & clipping	no deficit
8	57/M	SAH,IVH	4	VA-PICA jct.	fusiform	Left	IV	FLTC & clipping	Lt.11th n. palsy
9	67/F	SAH,IVH	5	lateral medullary	saccular	Left	III	FLTC & clipping	expired, sepsis
10	46/F	SAH,IVH	2	VA-PICA jct.	saccular	Left	II	FLTC & clipping	no deficit
11	55/F	SAH,IVH	2	VA-PICA jct.	saccular	Left	III	FLTC & clipping	no deficit
12	36/F	SAH,IVH	5	telovelotonsillar	saccular	AVM, Left	IV	SOC & clipping	MD

*M=male ; F=female ; SAH=subarchnoid hemorrhage; GDC=Guglielmi detachable coiling ; AICA=anterior-inferior cerebellar artery ; PICA=posterior-inferior cerebellar artery ; VA=vertebral artery ; AVM=arteriovenous malformation ; N.=nerve; MD=moderate disability ; GR=good recovery ; FLTC=far lateral transcondylar ; IVH=intraventricular hemorrhage ; SOC=suboccipital

Results

Clinical characteristics

Twelve patients, 8women and 4 men, 36 to 71years(mean age, 55.8years) underwent surgical and endovascular treatment. The most common complaint of the patients on arrival was mental deterioration and two of 12 patients complained only of headache.

Radiologic characteristics

All 12 patients showed subarachnoid hemorrhage and seven of 12 patients showed intraventricular hemorrhage on initial brain computer assisted tomography(CAT) scan. There was only one patient with hydrocephalus on initial brain CAT scan. Most PICA aneurysms were located at the vertebral artery(VA)-proximal PICA junction(8/12), two at lateral medullary segment of PICA, one at the common trunk of the anterior inferior cerebellar artery(AICA)-PICA and the last was at the telovelotonsilar segment which was associated with distal arteriovenous malformation(AVM)(Fig. 2).

Fig. 1. Postoperative brain computed tomography image showing one third of condyle is removed until cortical bone of hypoglossal canal, and arrow indicates hypoglossal canal.

Treatment technique

We used the far lateral transcondylar approach as described earlier for the first two cases and the later eight cases were treated with the far lateral supracondylar approach without removal of atlas. Eight of the 12 cases were clipped and two were trapped. Case 1 was underwent occlusion by Guglielmi detachable coil(GDC) assisted with stent. The aneurysm of case 12 which was associated with AVM was clipped and the AVM nidus was extirpated.

Surgical result and complication

Five of 12 patients did not develop any postoperative neurologic deficit. Three of 12 patients developed cranial nerve deficits but were resolved by their discharge date except case 4(permanent facial nerve palsy). Three patients died as a result of initial poor neurologic status(case 1), septic complication (case 9) and case 6 whose intial angiogram did not show any aneurysm but she became comatose on 7days after initial ictus

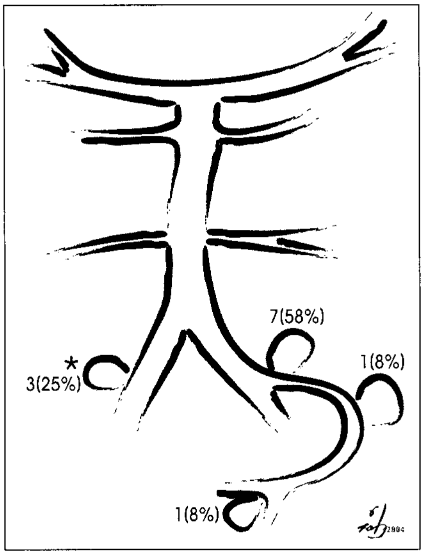

Fig. 2. Schematic posterior inferior cerebellar artery(PICA) aneurysm occurrence rate on our study was revealed. * : the one of three right PICA aneurysms is common AICA(anterior inferior cerebellar artery)-PICA origin.

and a follow-up angiogram showed PICA aneurysm but she died despite of surgical intervention. Case 12 remained moderately disabled mainly due to initial massive bleeding on posterior fossa. All patient except the dead patients was followed up without neurologic change during 3years (mean follow-up : 1~3yrs).

Case illustrations

Case 2

A 71-year-old female who experienced the sudden onset of headache and mental deterioration was transferred. On admission, she had no definite focal neurologic deficit except drowsy mentality. The CAT scan showed subarachnoid hemorrhage on all cisternal space especially the cerebellomedullary cistern. The angiogram showed an aneurysm on the VA-proximal PICA junction. The patient underwent far lateral transcondylar approach and the aneurysm was clipped. The patient was discharged without any problem(Fig. 3).

Case 7

A 38-year-old male experienced the sudden onset of severe headache and vomiting. On admission, he was alert without any other focal deficit. CAT scan showed an intraventricular hemorrhage with a small subarachnoid hemorrhage. On angiogram, there was an aneurysm at the lateral medullary segment of PICA. The patient underwent far lateral supracondylar approach without removal of the atlas and the aneurysm was clipped successfully. The patient was discharged without any focal deficit (Fig. 4).

Discussion

The outcome of the patients with good preoperative neurologic status was good as in other studies and several patients of poor grade(world federation of neurological surgery, WFNS) recovered without neurologic deficit or transient deficit[11]. That means PICA aneurysm must be treated even though patients were initially poor grade.

The transfemoral carotid angiography is standard technique in diagnosis of PICA aneurysms and it must evaluate the both vertebral artery and fill the proximal portion of the vertebral artery but three dimensional computed tomography angiography may be good alternative method[18].

AVMs in the posterior fossa were more frequently associated with aneurysm than those of the supratentorial fossa and aneurysms were responsible for bleeding in half of the cases[9,12,16,22,25].

The PICA has the most complex, tortuous and variable course and area of supply of the cerebellar arteries[14]. Thus we must individualize the plan to treat these aneurysms according to individual angiographic finding and other radiologic findings.

The origin of the PICA at the VA may vary from below the foramen magnum to the vertebrobasilar junction[15]. The PICA arises typically from the intracranial portion of the VA(80~95%), on average 8.6mm above the foramen magnum and 16.9mm below to the vertebrobasilar junction[15].

The PICA can be divided as five segments based on its relationship to the medulla oblongata and the cerebellum. The five segments are 1) anterior medullary segment, extending from

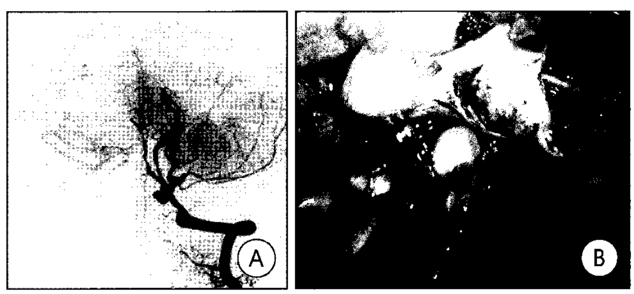

Fig. 3. The angiogram shows the aneurysm on the left vertebral artery and the proximal posterior inferior cerebellar artery(A). Postoperative photography shows the clipped aneurysm while preserving the vertebral artery and the posterior inferior cerebellar artery patency(B).

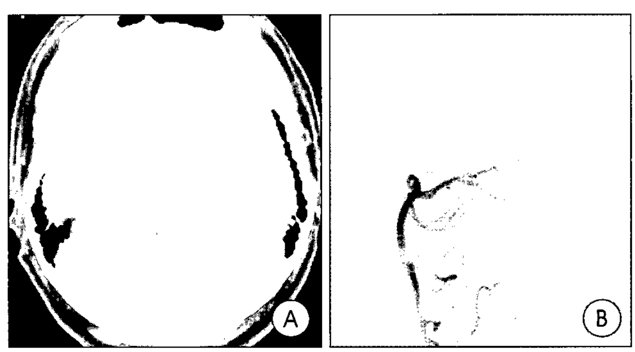

Fig. 4. The preoperative computed tomography image shows only intraventricular hemorrhage(A), and the angiogram shows an aneurysm on the lateral medullary segment of the posterior inferior cerebellar artery(B).

the origin of PICA at VA to inferior olivary prominence 2) lateral medullary segment, extending to the origins of ninth, 10th, 11th cranial nerves, 3) tonsillomedullary segment, extending to the level of the tonsillar midportion, 4) telovelotonsillar segment, extending to the cortical surface of cerebellum and 5) cortical segment, extending to the cerebellar vermis and hemisphere[15].

On the basis of embryological vascular development, basilar and vertebral arteries are formed from plexiform formations around the brainstem, with transverse branches connected by longitudinal remnants of the prominent lateral channel[19]. The PICA also develops from these plexiform formations, which may lead to many anatomic variations of the PICA. Such developmental characteristics would act as an important congenital factor for aneurysm formation at the straight portion of arteries. In other words, there would be fragile points at the straight portion of the PICA[14].

There have been many surgical approaches and modifications to treat aneurysms and tumors around these anterior medullary portions since 1978[1,5-7,20]. But Rhoton Jr.[24] concluded the far lateral approach in his recent publication. He described the far-lateral approach including 1) dissection of the muscles along the posterolateral aspect of the craniocervical junction to permit an adequate exposure of the transverse process of atlas and the suboccipital triangle; 2) early identification of the vertebral artery either above the posterior arch of the atlas or in its ascending course between the transverse process of the atlas and axis; 3) a suboccipital craniectomy or craniotomy with removal of at least half of the posterior arch of the atlas[3,23,24].

The authors used this far-lateral approach in the intial two cases and eight cases were approached without removal of the posterior arch of the atlas. We think it is not necessary to remove the posterior arch of the atlas because it is essential to secure proximal control of the aneurysm but not to mobilize the proximal artery in aneurysmal surgery and it is enough to control the proximal artery of aneurysm during surgery without removal of the posterior arch of the atlas.

There are three modifications to the extent of drilling the occipital condyle; the transcondylar approach directed through the occipital condyle or the atlanto-occipital joint and adjoining parts of the condyle; the supracondylar approach directed through the area above the occipital condyle; and the paracondylar exposure directed through the area lateral to the occipital condyle[24]. The transcondylar extension accompanied by drilling the condyles allows a more lateral approach and provides access to the lower clivus and premedullary area. The supracondylar approach provides access to the region of and medial to the hypoglossal canal and the jugular tubercle[24].

We used the transcondylar approaches in the initial two cases but they were too extensive and time consuming so in the later eight cases we undertook the supracondylar approaches. We drilled the occipital condyle until the second cortical bone or venous plexus covering the hypoglossal canal was exposured, while preserving the atlanto-occipital condyle. And then we decided whether or not to drill the jugular tubercle based on the level of aneurysm of the lateral and anterior posterior view of the angiogram. The articles said the aneurysm above the vertebrobasilar junction should be treated by an extreme lateral approach[2]. But the vertebral artery may be displaced to either side and such a extensive approach is not necessary. Thus we thought the most important factor to decide the surgical approach is the laterality of the aneurysm to midline and the height of the aneurysm above the foramen magnum on the angiogram. The PICA is the most complex, tortuous and variable in course and supply so we must individualize treatment plan as we mentioned earlier.

As the jugular tubercle is removed extradurally the cranial nerves, which course along the back margin of the tubercle and are intradural, will not be visualized. As the drilling proceeds, bone will be removed from below the cisternal segment of the accessory and the vagus nerves that course above the tubercle just inside the dura. Caution is required in removing the jugular tubercle to avoid damaging the lower cranial nerves either by direct trauma, by stretching the dura, or by the heat generated by the drilling[24]. Authors had the experience to drill the jugular tubercle intradurally as in the drilling of the anterior clinoid process in a proximal intracerebral artery aneurysm during the trapping of a fusiform aneurysm arised from distal PICA to vertebrobasilar junction preserving the lower cranial nerves(not included this study). We think it maybe alternative method to remove jugular tubercle not prepared at extradural stage[4].

The distal PICA aneurysms are frequently associated with AVMs and aneurysms of other parts and so it is believed congenital factor acts as development of distal PICA aneurysms[8,17]. It is another major issue to treat PICA aneurysm by surgical clipping (including trapping) or GDC embolothoerapy. Of course, the ideal treatment of a truly saccular lesion is clipping or endovascular obliteration of the aneurysm neck with preservation of the lumen of the PICA. Lewis et al[14] described in their recent review at this point. They said direct inspection of the affected segment provided several significant advantages compared with endovascular therapy, allowing for better decisions regarding the need to sacrifice or spare the parent vessel and clips placed obliquely across the PICA could be spare the patency of perforating vessels. And surgery is also preferable whenever a significant hematoma needs to be evacuated, when a coexistent AVM is identified that can be simultaneously removed with a low risk. They described surgical-anatomical classification deciding whether the PICA can be potentially sacrificed at that point. These segment categories include proximal (anterior and lateral medullary) segments, which invariably contribute branches to the brainstem; transitional (tonsillomedullary) segments, which may produce some perforating vessels; and distal (telovelotonsillar and cortical) segments, from which no brainstem blood supply arises. But authors trapped two cases of proximal PICA aneurysms which did not show any postoperative neurologic deficit. It might be contributed by prominent collateral flows.

Conclusion

Until recently, treatment outcomes and surgical results of PICA aneurysms are poor but in our series good outcomes are obtained by far lateral supracondylar approach without removal of the posterior arch of the atlas. We believe that if we gain more surgical experience, the surgical outcome and clinical outcomes will be better than now.

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Commentary

Proximal posteroinferior cebellar artery(PICA) aneurysms are challenging to treat surgically, with high reported perioperative complication rates. Many series report lower cranial nerve palsies occurring in 20 to 60% of patients. These palsies have been attributed to surgical manipulation of the lower cranial nerves during aneurysm dissection and clipping. As a result, some advocated an endovascular approach as a primary treatment modality for PICA aneurysms[2,4]. This is a timely report, because a number of institutions have abandoned surgical therapy for posterior circulation aneurysms and refer all of them to endovascular therapy.

This interesting article details eleven PICA aneurysms(all ruptured) operated on via a far lateral suboccipital approach. The rate of cranial nerve dysfunction(25%) was on average and overall outcomes were better than have been reported in other series of comparable or larger size. In the era of minimally invasive surgery, the authors' effort to minimize the size of craniotomy and as a result to reduce procedure-related morbidity is admirable. The extent of condylar bone removal and whether to sacrifice the posterior C1 arch is a matter of debate. The amount of condylar bone removed depends on how much the condyle is likely to impede the view. The trajectory is caudal to rostral, and the working space between and/or around the lower cranial nerves.

This approach provides good access to vertebral artery and the origin of the PICA[1,3]. Our experience tells us, no obligation was imposed on removal of C1 posterior arch and condylar bone. With experience accumulates, the composites of suboccipital triangle don't need to be dissected but only need to be retracted to permit good exposure. The authors' transformation from transcondylar to supracondylar approach is worth admiring as an effort for minimal invasive surgery. Most of all, however, what should be kept in mind is every surgical strategy could be modified according to pateient's presentation. The authors have provided excellent documentation of outcomes and their successful modification of far lateral approach.

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