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Aneurysms of the medullary segments of the posterior-inferior cerebellar artery: considerations on treatment strategy and clinical outcome

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Abstract

Proximal aneurysms of the medullary posteroinferior cerebellar artery (PICA) tract are peculiar due to critical anatomical location, small size and tortuosity of the parent vessel, close origin to brainstem perforators, and fragility of the sac wall. Moreover, most patients present after bleeding, increasing the challenges. Aim of this study is to evaluate the treatment modality and outcome of these patients during the last decade at the University Clinic of Torino. Databases of the Neurosurgical and Neuroradiological Department of the University of Torino were analyzed to retrieve patients treated for aneurysms of the medullary PICA tract. Charts and neuroradiological documentation were revised to complete the database. Of 621 patients treated for an intracranial aneurysm, 23 had PICA aneurysm, 18 located at the medullary tract. Only two were unruptured and 16 were ruptured aneurysms. Sixteen underwent endovascular treatment and two underwent surgery. In six cases the aneurysm was cured by parent vessel occlusion. At 6 months follow-up, the Glasgow outcome scale was high (5 and 4) in 16 patients; two patients had died in the acute phase, for reasons unrelated to the procedure. If not adequately compensated, parent vessel occlusion associates with high risks of ischemia and related brain swelling. In the present series sufficient collateral flow contributed to a good tolerance toward occlusion in all cases. Despite the small size of the present series, most treated cases presented a good outcome. Nevertheless, distal revascularization of the occluded artery would be indicated where collateral flow is insufficient.

Keywords

Posterior-inferior cerebellar artery (PICA) aneurysm; Cerebellar artery; Aneurysm; Medullary; Proximal; Parent vessel occlusion; Treatment

Introduction

Proximal aneurysms of the postero-inferior cerebellar artery (PICA) account for approximately 1–3 % of all aneurysms [1–4]. Since the definition of a proximal aneurysm varies throughout the neurosurgical literature, proximal PICA aneurysms are defined here as those originating on the medullary PICA tract, that portion that gives origin to perforating arteries to the brainstem. Thus, the contemplated tract includes the anteromedullary, the lateromedullary and the proximal portion of the tonsillomedullary tract, according to the classification of Lister et al. [5].

Aneurysms of the PICA having a neck that also involved the vertebral arteries are not considered since these pose technically a different type of problematic.

Most of the aneurysms at this location present as ruptured [1, 6] and treatment challenges are not indifferent: endovascular treatment is complicated not only by the aneurysm shape, but also by the tortuosity of vessels to be navigated with microcatheters. Surgery has to deal with critical surrounding anatomical structures, including brainstem and lower cranial nerves, well described by Kawashima et al. [7].

Aim of this study is to analyze data available on patients treated for this sort of rare aneurysms over a decade at the University Clinic of Torino to gain some further awareness on related treatment challenges and difficulties.

Patients and methods

The neurosurgical and neuroradiological prospective database of the University Clinic of Torino on cerebral aneurysms was analyzed for intracranial aneurysms for the time span 2000–2010. Neuroradiological images and medical reports were checked to select for medullary PICA aneurysms and to complete the database.

As concerns our treatment protocol for subarachnoid hemorrhage (SAH) related aneurysms, our clinic has the following policy: after clinical evaluation at admission and if computed tomographic angiogram (CTA) scan had not already been performed at a peripheral referring hospital, CTA or digital subtraction angiography (DSA) are undertaken to study the vessel tree. Informed consent is taken for imaging as well as for eventual endovascular and/or surgical treatments. The choice of the treatment strategy is dictated by vascular characteristics, including neck and sac features, by the age of the patient, eventually his preference, and is the end product of the discussion between the endovascular and the surgical

team in the presence of the anesthetist. All procedures are undertaken under general anesthesia. The endovascular procedure is performed through femoral access with selective catheterization and coiling of the aneurysm sac or eventual coil occlusion of the parent vessel. Surgery for these aneurysms is performed through a low retrosigmoid approach. Ruptured aneurysms are usually treated in the first hours after arrival 'as soon as possible' and in all cases in the first 24 h after bleeding, also when the patient is referred from peripheral hospitals.

In all ruptured PICA aneurysms an external ventricular drainage is positioned and in cases with intra-ventricular hemorrhage associated with hydrocephalus the positioning of an external ventricular drainage occurs even before the aneurysm is treated. Outcome measures include Glasgow Outcome Score (GOS) defined at 6 months neurosurgical follow-up.

Ischemia was tracked based on early follow-up CT scans and with chart notes comprising eventual clinical changes.

Results

Out of the retrieved 621 patients with intracranial aneurysms, 26 patients with aneurysms of cerebellar arteries were found. Two patients with superior cerebellar artery (SCA) aneurysms (one having bilateral SCAs and a further bleb on the posterior cerebral artery (PCA)), one patient with an antero-inferior cerebellar artery (AICA) aneurysm and 23 patients with PICA aneurysms.

A total of 18 medullary PICA aneurysms were found and their location on the PICA tracts was the following: 3 on the tonsillomedullary segment, 7 on the laterotonsillary segment, 8 on the anteromedullary segment. One patient with an anteromedullary segment aneurysm also harbored an aneurysm at the middle cerebral artery.

Mean age was 62.4 years (standard deviation 13.43); male–female ratio was 1:6. Only two aneurysms were unruptured. Hunt Hess (HH) grade at admission was II in 7 patients, III in 6 patients and IV in 3 patients. WFNS grade I was found in 3 patients, grade II in 5 patients, grade III in 4 patients, grade IV in 3 patients and grade V in 1 patient.

Intraventricular hemorrhage (IVH) was found in 12 patients. The Fisher grade on admission CT scan was IV in 12 cases, of III in 3 cases and of II in 1 case (Fig 1).

None of our patients in this series had known family history for SAH or intracranial aneurysms. Only one patient harbored another aneurysm, unruptured and supratentorial.

Another patient presenting with SAH had also a history of abdominal aortic aneurysm. Hypertension was found in 63 % of patients, dyslipidemia in 71 %, and smoking history in 33 %. One patient was affected by Parkinson disease.

Treatment

Surgical treatment

Treatment was surgical only in 2 of 18 patients: in one case (patient nr. 10, Table 1) aneurysm clipping was optioned for a giant unruptured lateromedullary, partially thrombosed PICA aneurysm with mass effect and in the other case (patient nr. 1, Table 1) surgical exploration was decided after severe vasospasm complicating endovascular maneuvers during treatment of an anteromedullary PICA aneurysm in a patient with Fisher grade IV and HH4. In the latter case the vessel was found thrombosed, and the suspicion of a dissecting fusiform aneurysm was confirmed so that decision went for positioning of a clip proximal to the aneurysm.

Endovascular treatment

All other 16 patients underwent endovascular treatment following diagnosis. Selective coiling of the aneurysm could be performed in 11 cases. One of these patients (nr. 5, Table 1) treated with coiling for a ruptured anteromedullary PICA aneurysm required a redo procedure for aneurysm regrowth related to coil compaction 3 months later.

In five of these 16 patients (31.25 %) the parent vessel was closed endovascularly. Parent vessel occlusion had been performed in four of these patients due to the finding of 'no/broad neck' and in the remaining case (nr. 4, Table 1) the aneurysm originated on a small collateral of the proximal tonsillomedullary PICA where selective navigation was not considered to be safe. In addition common features mentioned for these procedures include: vertebral artery difficult to navigate keeping safe control for coiling in the PICA artery, incoming arterial spasm in a patient having had SAH, and the finding of a broad necked or even a fusiform, likely dissecting aneurysm and early good collateral flow.

Ischemic complications

Severe acute ischemia requiring urgent posterior fossa decompression due to posterior fossa hypertension was required in two patients: one had been treated for his anteromedullary PICA aneurysm with endovascular coiling of the sac (nr. 11, Table 1) and the other had undergone parent vessel occlusion for a broad necked lateromedullary PICA aneurysm (nr. 9, Table 1).

In four patients radiological signs of ischemia on the PICA territory were noted on post-procedural CT scan, these patients were either completely asymptomatic or symptoms did resolve by discharge: two patients had been treated with selective aneurysm coiling (nr. 2 and nr. 6, Table 1) one with parent vessel occlusion (nr. 18, Table 1) and one had been clipped for his giant thrombosed aneurysm (nr. 10, Table 1). Finally, in one patient where parent vessel occlusion had been performed, ischemia was not on the PICA territory, but in relation with a P2- to P3-occlusion of probable embolic nature (nr. 16, Table 1).

Permanent hydrocephalus

Positioning of a ventriculo-peritoneal shunt was found for three patients; however, this might be an underestimation. An episode of sepsis reported by the colleagues of a peripheral hospital complicated the recovery of one patient.

Outcome at 6 months

At 6 months follow-up GOS was V in 10 patients, IV in 6 patients and two patients had died in the acute phase, due to causes unrelated with the procedure itself.

In particular the two patients that underwent urgent decompressive craniotomy had already a low WFNS score at presentation. However, of the six patients with ischemia one had a GOS of V and all other a GOS of IV.

Looking at the outcome score of the six patients that underwent parent vessel occlusion three had a GOS of V and three a GOS of IV.

Discussion

The definition of proximal aneurysm The definition of proximal and distal varies among publications and according to the aim of the authors: for example in a paper on distal cerebellar aneurysms, the term 'distal' includes all those aneurysm that arise on parent vessels branching from the main arteries of the circle of Willis [8–11]; furthermore, many available series deal with posterior circulation aneurysms, and often the location along the cerebellar artery segments is not specified [4, 12, 13]. Also in most series [14–16] vertebral-PICA junction aneurysms are included within the proximal PICA aneurysms.

We deliberately decided not to include those, to focus on proximal aneurysms having only the PICA as parent vessel. In the present analysis, the definition of 'proximal PICA' includes the so to say 'medullary' PICA tract—not only the first two segments according to Lister's classification [5], defined by Lewis as proximal, but also part of the 'transitional PICA', that is the tonsillomedullary PICA tract [17], since this segment might also give origin to brainstem perforators. Heterogeneity of reported experience and the relatively small size of such series make it difficult to draw conclusions regarding the best treatment for these cases. Most reported series deal either with surgical or with endovascular treatment experiences [14–16, 18, 19].

The present study includes both surgical and endovascular treatment and the size of the analyzed series is well comparable to others [14, 15]. In this analysis only treated patients are included so no conclusions can be drawn on patients with diagnosis of proximal PICA aneurysm where treatment had not been considered advantageous due to general medical conditions or due to too low coma score even after intracranial pressure (ICP) improving maneuvers and optimized medical care.

Hemorrhagic complications

The presentation of our PICA aneurysms patients, with a 89 % rupture event, is well comparable with other series where rupture rate ranges between 79 and 100 % [6, 14, 16, 20]. Intraventricular hemorrhage is a common feature: Kallmes et al. [21] studied the hemorrhagic patterns of PICA aneurysms shown on CT scans. The authors suggested that the incidence of IVH or acute hydrocephalus was 95 %. Sadato et al. [22] showed that 75 % of all found distal PICA aneurysms presented with Fisher Grade IV.

Our data goes along well with these findings as 75 % of our cases presented with Fisher Grade IV. Furthermore all these Fisher grade IV cases were due to intraventricular hemorrhage rather than to intraparenchymal clot, which is well understandable, considered the anatomical location

Hydrocephalus

The proximity of the 4th ventricle is the reason for a high percentage of IVH. Our protocol always aimed at aggressive treatment for IVH associated hydrocephalus with immediate positioning of an external ventricular drainage, which often contributed to dramatically improve the patient's neurological status. The impact of hydrocephalus on the neurological grade at presentation and its reversibility with rapid treatment partially contributes to explain how in the present series, despite HH grade was 3 and 4 in 50 % of patients at presentation, the GOS at 6 months is dramatically high: IV and V in 89 % of patients. However, two patients that had been successfully coiled for their ruptured PICA aneurysm died in the acute phase, due to severe medical complications.

Reruptures

Rebleeding is known to be extremely high for aneurysms at this site: 78 % [23]; thus treatment should not be deferred. Our treatment policy goes in that direction—we experienced no rebleeding in this series, neither during the acute phase, nor during the 6 months follow-up period.

In the present series six patients (33 %) required occlusion of the parent vessel for the treatment of their ruptured aneurysm: in one case the endovascular procedure was aborted due to difficulties with selective microcatheter navigation related to tortuous vertebral arteries and intraprocedural arterial spasm. At surgical exploration the proximal PICA was already thrombosed and a clip was positioned proximally to the aneurysm. In all other cases endovascular parent vessel occlusion was favored, due to the broad neck of the aneurysm that did not allow coil placement for selective aneurysm occlusion.

No intra-procedural ruptures occurred, and this is also likely due to the relatively prompt decision in favour of parent vessel occlusion for cases where selective treatment was felt to become more complicated.

Ischemic complications

The present series shows that ischemia in these patients can have several causes: increased ICP in patients with intraventricular hemorrhage, lack of tolerance of parent vessel occlusion, due to collateral insufficiency, embolization related to arterial catheterism, local spasm probably related to arterial manipulation, occlusion of a perforator, surgical brain retraction. No cases of brainstem ischemia were noted, with exception of a case with transitory dysphagia. Though, this is a well described occurrence in other series where brainstem ischemia might present with a Wallenberg syndrome or with other alternate syndromes [24].

During DSA, a proper evaluation of collateral circulation can be archived through the balloon occlusion test. Collaterals for the PICA territory might originate from the SCA and from the AICA [25, 26] or even from the posterior meningeal artery [27]. In most cases, according to different authors, even the PICA infarct that might follow PICA occlusion is well tolerated [16, 28].

Nevertheless, besides technical difficulties related to positioning the balloon exactly in the planned occlusion site, perhaps even in conditions of acute vasospasm, the certainty that this flow can truly be sufficient is difficult to predict. With high-resolution angiographers useful and somehow predictive considerations can be performed on the basis of number, size and position of perforators, however, with the equipment we had available during the considered time span, this approach could not be considered systematically with acceptable reliability. The supplement of intraprocedural monitoring devices, as for example somatosensory and brainstem auditory and motor evoked potentials applicable both in the endovascular and surgical setting, or, intraoperatively, the use of indocyanine green videoangiography and transit time flowmetry could provide some helpful additional information on vascular tolerance to occlusion [29].

Alternative treatment approaches

Alternative endovascular strategies to endovascular occlusion for the treatment of not coilable aneurysms at sites of perforators and/or where parent vessel occlusion is not tolerated are stenting, stent assisted coiling or placement of flow diverters: however, so far only very anecdotal cases of stent placement for this district are published [30] and nevertheless, most cases concern vertebral-PICA junction aneurysms [31, 32]. Reasons are the difficult distal catheter control for stent placement and the risks associated with size and mechanical characteristics of available stents, which still seem too large and not soft enough to match too small and tortuous arteries as the PICAs.

Another strategy described for the treatment of PICA aneurysms is proximal vertebral artery occlusion with flow reversal [33].

Some PICA aneurysms can be relatively complex, due to fusiform and or dissecting characteristics, as well as even the origin of perforators from the aneurysm, so that not always a simple clip can solve the problem. The clip-wrap technique using different types of wrapping material—muscle, glue or gauze—and by carefully preventing contact between the latter wrapping material and cranial nerves to avoid adhesences, is somehow used for dissecting aneurysms to reduce (re-)bleeding and believed to reduce rupture [19, 34].

A further possibility that deserves a few considerations for cases where selective PICA aneurysm occlusion is not feasible, is parent vessel occlusion associated with revascularization [7, 13, 35]. PICA-PICA, 'side-to-side' bypass with aneurysm clipping has been described for dissecting proximal PICA aneurysms [13, 19], PICA-PICA 'end-to-side' bypass was described for the resection of a lateromedullary ruptured PICA aneurysm [36], direct PICA reanastomosis [13], aneurysm resection and 'end-to-end' superficial temporal artery graft insertion [37], direct proximal PICA reimplantation either in the VA or on the AICA [3, 13], occipital artery-PICA bypass [19] have been described. Nevertheless, the bypass, reanastomosis or reimplantation techniques require already a good experience with posterior fossa revascularization [19], and can be more difficult to prepare in a posterior fossa with an 'angry brain'; bypass failure is also a well known occurrence [38–40].

Considering the current status and looking back at our experience we could observe that for difficult endovascular cases parent vessel occlusion has luckily been well tolerated in most cases. This is a consequence of a good collateral flow that characterizes usually this district, and that is often underestimated. Taking this into account simplifies the treatment of these aneurysms in many cases, preventing complications from more complex procedures. However, for specific cases we feel that a switch to surgery could offer more solutions, ranging from straightforward clipping where endovascular navigation is difficult due to tortuous arteries, or where the aneurysm neck is broad, to revascularization where the need of parent vessel occlusion is likely, and finally to wrapping if the aneurysm cannot be clipped, a revascularization attempt fails and/or perforating arteries do not allow parent vessel occlusion.

Conclusions

In the present series endovascular treatment was the prevalent treatment modality. Nevertheless, we still believe that surgery represents a valid option, allowing at the same time clot evacuation, posterior fossa decompression and where needed revascularization procedures. Parent vessel occlusion was performed by early visualization of flow compensation in the following: neck morphology unsuitable for coiling, dissecting nature of the aneurysm walls or difficulties of selective navigation. Timely recognition of endovascular difficulties might prevent major challenges as bleedings during endovascular maneuvers. Distal revascularization techniques should be kept for cases where flow compensation is not expected or not seen in the early postocclusion phase or better, if test occlusion is not tolerated, and where parent vessel occlusion is required.

No regrowths or reruptures were found in this patient's series. Most PICA aneurysms present as ruptured and in general hydrocephalus due to IVH accounts for the severe status of these patients at arrival. Prompt ventricular drainage increases the probability of a reversal of that status with high impact on final outcome. Nevertheless, it is well known that posterior fossa hemorrhage is a severe event associated with the loss of some patients in the initial days despite all efforts.

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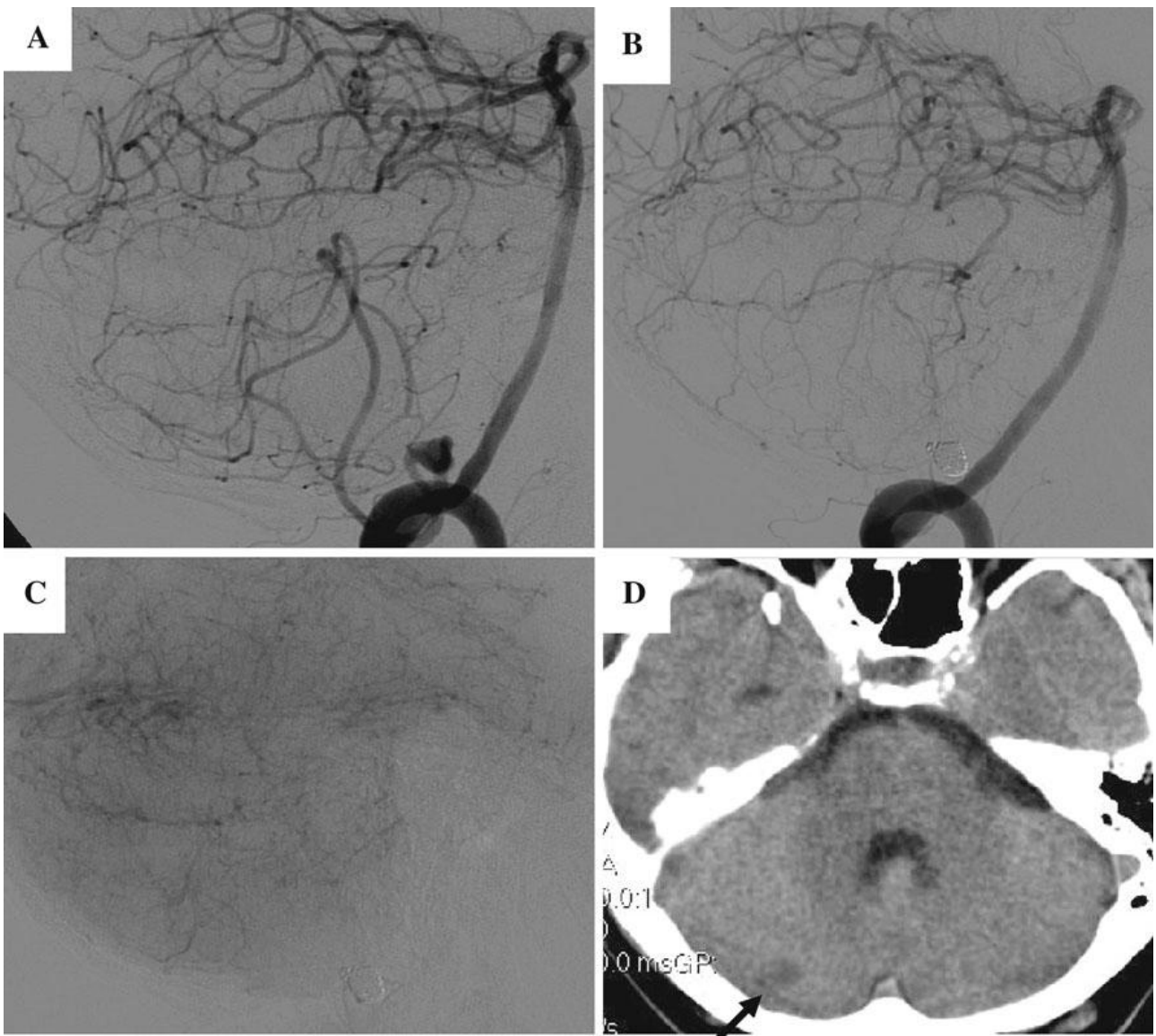


Fig. 1 In this patient the large neck tonsillomedullary PICA aneurysm was occluded together with its parent vessel by endovascular coiling (a, b). Adequate leptomeningeal collaterals from the SCA and the AICA provide for a good filling of the PICA territory in the arteriolar phase at control angiography (c). A small ischemic lesion can be observed at CT scan (d) that remained completely asymptomatic

Table 1 Patients treated for medullary PICA aneurysms (University Clinic of Torino 2000–2010)

Patient nr.	Age	Sex	Ruptured	PICA tract	Shape	WFNS	Hunt Hess	Fisher	IVH	Treatment	Parent vessel occlusion	Reason for parent vessel occlusion	Ischemia territory	Post-fossa dec.	VP shunt	Notes	GOS at 6 months
1	64	F	x	AM	FF, D	II	III	II		E + C	x	Tortuous vertebral artery, spasm thrombosis					5
2	57	F	x	AM	S	I	II	III		E			PICA				5
3	74	F	x	AM	S	III	III	IV	x	E							5
4	66	F	x	AM	S	IV	IV	IV	x	E	x	Aneurysm of PICA collateral			x		5
5	56	M	x	AM	S	II	II	IV	x	E + E at 3 months							5
6	49	F	x	AM	S	I	II	IV	x	E			PICA				5
7	57	M	x	AM	S	II	II	IV	x	E (PICA) + C (MCA)							5
8	82	F	x	LM	S	II	III	IV	x	E							5
9	73	F	x	LM	S	I	II	III		E	x	No neck	PICA	x			4
10	70	F		LM	S	I				C			PICA		x	Aneurysm giant and thrombosed	4
11	36	F	x	LM	S	V	II	IV	x	E			PICA	x			4
12	57	F	x	LM	S	IV	IV	IV	x	E						Death during hospitalization	1
13	60	F		LM	S					E							5
14	39	M	x	LM	S	IV	IV	IV	x	E						Death during hospitalization	1
15	80	F	x	LM	S	IV	III	IV	x	E							4
16	79	F	x	pTM	S	II	II	II		E	x	No neck	Embolic at P2–P3 of PCA		x	Transitory dysphagia	4
17	73	F	x	pTM	S	IV	III	IV	x	E	x	No neck					5
18	52	F	x	pTM	S	IV	III	IV	x	E	x	No neck	PICA			Sepsis	4

F female, M male, PICA posterior-inferior cerebellar artery, AM anteromedullary, LM lateromedullary, pTM proximal tonsillomedullary tract, FF fusiform, D dissecting, S saccular, E embolisation, C clipping, PCA posterior cerebral artery, post fossa dec posterior fossa decompression, VP shunt ventriculoperitoneal shunt, GOS Glasgow Outcome Score