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# AICA-PICA Variant Aneurysms: Spectrum of a rare aneurysm and management

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## ABSTRACT

**Background:** Aneurysms of the posterior circulation account for 10–15% of all aneurysms. Among posterior circulation aneurysms, anterior inferior cerebellar artery (AICA) aneurysms account for 1–2%, and among AICA aneurysms, AICA–PICA variant aneurysms are even rarer. Only 13 cases have been reported in the literature (Table 1).
**Objective:** The aim of the present study was to evaluate the management strategy for these rare aneurysms.
**Materials and Methods:** We reviewed 8 previous studies comprising 13 patients, along with our study comprising 2 patients, to identify a novel method of treatment and complications pertaining to the different treatment modalities.
**Results:** Endovascular and microsurgical procedures can be performed to treat these aneurysms, but endovascular treatment appears simpler than microsurgical treatment for aneurysms located at the meatal and post-meatal portions of the AICA.
**Conclusion:** In AICA–PICA variant aneurysms, parent vessel occlusion is very detrimental, as the whole brain area supplied by the PICA is supplied by the AICA. Endovascular treatment is a better option for aneurysms involving the meatal and post-meatal segments of the AICA.

***Keywords****: AICA, PICA, Aneurysms, Variant*

## INTRODUCTION

Aneurysms of the posterior circulation account for only 10–15% of all intracranial aneurysms. Amongst the posterior circulation aneurysms, AICA aneurysms account for only 1–2%. AICA aneurysms can be associated with arterio-venous malformations (AVM), cerebello-pontine angle tumors, moyamoya disease, or may be an AICA–PICA variant. Agenesis of the PICA leads to a well-developed AICA so that it can supply the areas that would have been perfused by the absent vessels. This is known as the "AICA–PICA variant," with an overall prevalence rate of 20–24% in the literature. As far as aneurysms of the AICA–PICA variant are concerned, the exact cause is not known. The aneurysms may develop due to increased blood flow in the variant or a vascular injury such as dissection.[1]

AICA originates from the basilar artery and encircles the pons near the pontomedullary sulcus. After coursing near and sending branches to the nerves entering the acoustic meatus and the choroid plexus protruding from the foramen of Luschka, it passes around the flocculus to reach the surface of the middle cerebellar peduncle and terminates by supplying the lips of the cerebellopontine fissure and the petrosal surface of the cerebellum. AICA usually bifurcates near the facial and vestibulocochlear nerves to form a rostral and caudal trunk. The rostral trunk courses along the middle cerebellar peduncle to supply the upper part of the petrosal surface, and the caudal trunk passes near the lateral recess and supplies the lower part of the petrosal surface.

The trunk of AICA is divided into four segments: anterior pontine, lateral pontine, flocculopeduncular, and cortical. The lateral pontine segment is again subdivided into three segments: pre-meatal, meatal, and post-meatal. The pre-meatal segment begins at the basilar artery and courses around the brainstem to reach the region of the meatus. The meatal segment is located in the vicinity of the internal acoustic meatus. The post-meatal segment begins distal to the nerves and courses medially to supply the brainstem and cerebellum. The meatal segment thereafter forms a laterally convex loop, the meatal loop, directed towards or into the meatus.

The branches of AICA are labyrinthine (internal auditory) arteries, which supply the facial and vestibulocochlear nerves and adjacent structures; recurrent perforating arteries, which supply the brainstem; and the subarcuate artery, which enters the subarcuate fossa to end in the bone below the superior canal. It may, however, infrequently supply the distal territory of the labyrinthine arteries.

Anatomical variants of the AICA and PICA occur. They are classified into four types according to their origin and distribution of blood supply. Type I is a single trunk originating from the proximal basilar artery (BA), with the BA having two peripheral branches that act as the AICA and PICA. Type II is a bifid PICA originating from an intradural segment of the vertebral artery (VA). Type III is a bifid PICA originating from the vertebrobasilar junction, and Type IV is a PICA without an AICA. Depending on its origin, the AICA–PICA covers different territories. Aneurysms arising from the AICA–PICA variant are extremely rare; there are only 13 cases reported in the literature.

**CASE HISTORY:**

**Case I:** A 47-year-old lady presented with headache, vomiting, and transient loss of consciousness.

There was no history of any comorbid illness such as hypertension, diabetes mellitus, or bleeding diathesis. On examination, her GCS was E1V2M5, and neck rigidity was present. Initial CT scan of the brain revealed subarachnoid hemorrhage in the prepontine cistern with extension into the left cerebellopontine cistern.

Digital subtraction angiography (DSA) revealed an aneurysm from the left AICA, measuring 4 mm × 2 mm, with a well-defined neck and arising from the meatal segment (Fig. 1). It was evident from DSA that the PICA was absent and the AICA was dominant, representing an AICA–PICA variant (Fig. 2).

The aneurysm was clipped by left retrosigmoid sub-occipital craniotomy (Fig. 3). Postoperatively, the patient developed transient VIIth cranial nerve palsy, which resolved over a span of 5 months, and mild sensorineural hearing loss on the left side.

**Figure 1: Aneurysm arising from AICA (Meatal segment )**



**Figure 2: DSA showing left AICA aneurysm with absent PICA**

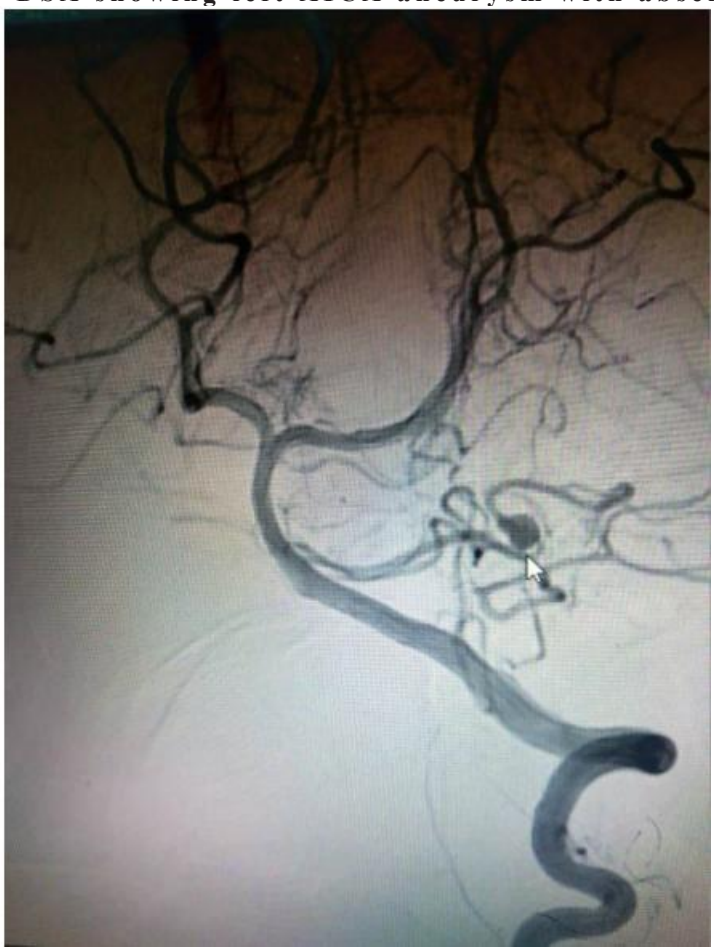
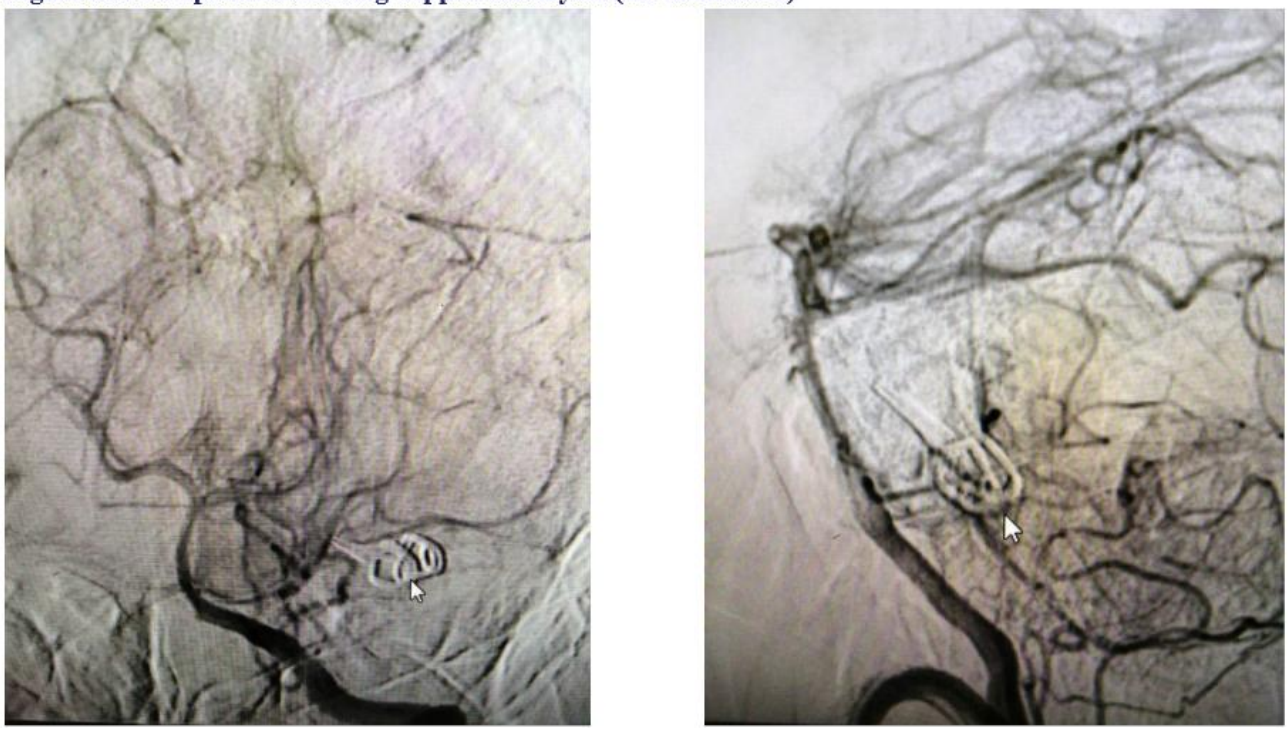


**Figure 3: Post ope DSA showing clipped aneurysm (AP & Lateral)**



**Case II:** A 51-year-old lady presented with headache and neck pain of sudden onset. There was no co-morbid illness. On examination, her GCS was 15 with neck rigidity. Initial CT scan of the brain revealed subarachnoid hemorrhage. 3-D CT angiography of the brain revealed a left AICA aneurysm in the meatal segment, with the neck partially within the meatus.

PICA on both sides was absent. The aneurysm was clipped by left retrosigmoid sub-occipital craniotomy and drilling of the meatus. Postoperatively, there was transient VII cranial nerve palsy.

**Table 1 Reviewof literature ofAICA-PICA Variant aneurysms**

| Author | No. of Cases | Presentation | Location | Size | Origin of Trunk | Treatment | Outcome |
|---|---|---|---|---|---|---|---|
| Kojima[4] 1996 | 1 | Reportedin Japanese | | | | | |
| Ebara[5] 1999 | 1 | SAH | Distal | Small | BA | MSOC | HP,LCNP,Ataxia |
| Baskaya[6] 2006 | 1 | SAH | Distal | Small | BA | MSOC | Good |
| Gopalakrishnan[7] 2009 | 2 | SAH<br>SAH | Distal<br>Distal | Small<br>Small | BA<br>BA | MSOC<br>RMSOC | Hemo. stable<br>Vegetative |
| Suh[8] 2011 | 5 | SAH<br>SAH<br>Incidental<br>Incidental<br>SAH | Proximal<br>Proximal<br>Proximal<br>Proximal<br>Proximal | Small<br>Small<br>Small<br>C<br>Large (15mm) | NA | Coiling | Good<br>Good<br>Good<br>Good<br>Good |
| Doigawa[9] 2015 | 1 | Masseffect | Distal | 3 cm | BA | Endovascular trapping&<br>Surgical thrombectomy | Good |
| Akhtar[10]2016 | 1 | SAH | Distal | Small | NA | MSOC | Good |
| Ansari[11]2018 | 1 | Masseffect | Proximal | Large (18mm) | VA | RMSOC | Good |
| Ourcases2018 | 2 | Masseffect<br>Headache | Meatal<br>Meatal | Small<br>Small | VA<br>VA-BA junction | RMSOC<br>RMSOC | FacialPalsy<br>Good |

SAH– SubArachnoidHemorrhage,BA– BasilarArtery,VA– VertebralArtery,MSOC– MidlineSub OccipitalCraniotomy,RMSOC– Retro Mastoid Sub OccipitalCraniotomy,HP– Hydrocephalus,LCNP– LowerCranialNervePalsy,NA– NotAvailable.

**Table 2: Summary of AICA aneurysms in the literature**

| | Total | Pre meatal | meatal | Post meatal |
|---|---|---|---|---|
| Number | 47 | 16 | 21 | 10 |
| Menage(years) | 53 | 54 | 52 | 53 |

| | | | | |
|---|---|---|---|---|
| Female | 32 | 14 | 12 | 06 |
| Presentation<br>□ SAH<br>□ □ SAH + V/VI/VIII/LCNP□ □ V /VII/VIII<br>□ Incidental | 27<br>09<br>06<br>05 | 09<br>02<br>01<br>04 | 10<br>07<br>04<br>00 | 08<br>00<br>01<br>01 |
| SurgicalManagement<br>□ □ Clippi ng□ □ Tra pping<br>□ □ Trapping+ Bypass□ □ Resectio n+ endto endsuture | 08<br>10<br>1<br>2 | 0<br>4<br>0<br>0 | 8<br>5<br>1<br>2 | 0<br>1<br>0<br>0 |
| Endovascular Management<br>□ □ Coilin g<br>□ □ StentAssistedCoi ling□ □ PAOusingCo ils/ NBCA | 4<br>3<br>14 | 3<br>3<br>4 | 0<br>0<br>4 | 1<br>0<br>6 |

**DISCUSSION**

AICA aneurysmsare rare. Published seriesindicated 47 AICA aneurysms inthe literature (Table 2).Theseaneurysms arise in relation toAVM, moya-moya disease, dissection or A I C A –PICA variant. There are considerable variations in the anatomy of the vertebra-basilar system. The most common variation is agenesis of the right PICA followed by agenesis of the left PICA as reported in literature. An inverse relationship between the sizesof the AICA and PICA is thought to exist. Agenesis of PICA leads to well developed AICA so that it can supply the areas that would have been perfused by the absent vessels. This is AICA-PICA variant. Overall prevalence rate of 20 -24% as reported in literature. Only 13 cases of AICA- PICA variant aneurysms have been described in literature(Table-2).7 of these aneurysms were treated microsurgically,6 were treated by endovascular method. As far as the aneurysms of the AICA-PICA variant are concerned, the exact cause is not known. The aneurysms may have developed due to increased blood now in the variant artery or a vascular injury such as dissection. Anatomical variations of AICA-PICA are classified into 4 types (TABLE-3).

**Table3:Variations of AICA and PICA. AICA–anterior inferior cerebellar artery, SAH–subarachnoid hemorrhage, LCNP– Lower Cranial Nerve Palsy , PAO–Parent Artery Occlusion , NBCA–n-butyl cyanoacrylate.**

| | |
|---|---|
| I | Single Trunk Originating from basilar arterywith 2 peripheral brunches as AICAandPICA |
| II | BifidPICAoriginatingfromvertebralartery |
| III | BifidPICAoriginatingfromvertebrobasilar junction |
| IV | PICAwithoutanAICA |

AICA has 4 segments: Anterior pontine,,lateralpontine,flocculopeduncularandcortical.Lateral pontine segment is again subdivided into: Pre-meatal,meatal and post-meatal segments. AICA aneurysms has a prediction for meatal segment. Management of these aneurysms need DSA and/ or 3D CT angiography of brain to see the location of the aneurysm in relation to the internal auditory meatus. Microsurgical treatment has been mainstay in the management of AICA aneurysms since the first surgicaltreatment ofthese aneurysmsby Gonzalez2 and Schwartz3. Micro surgicaltreatment consistsof direct clipping, trapping, trapping with bypass and resection with end to end anastomosis12.Endovascular

management consists of coiling, stent assisted coiling or occlusion of AICA using coils,n-butyl cyanoacrylate (NBCA), onyx. The management strategies for treatment differ according to the location and configuration of the aneurysms13 .As most pre-meatal aneurysms arise proximally, micro- catheter navigation into the aneurysms dome is often feasible and lies in a confined narrow space in the pre-pontine cistern, there by restricting surgical treatment. Meatal and post meatal aneurysms are often wide neck or fusiform, making these type of lesions difficult to preserve the parent artery, either by clipping or coiling. These efforts yield VII / VIII cranial nerve deficits and cerebellar infraction. These aneurysms can be technically difficult to manage surgically because of tight adhesion to the surrounding structures including nerves complex. Because of the small space, in situ clipping is difficult. The internal auditory artery, the location of which may vary, was not identified during surgery. Although several cases with pre-operative eight cranial nerve deficit showed improvementafter surgery, there are no outcome differences between surgery and endovascular treatment. The Endovascular treatment appears simpler than surgical treatment for aneurysms located at the meatal and post meatal portion of AICS.

**Surgical corridors:**

Tomost importantfactors inchoosingasurgicalapproachare:

a. The craniocaudally location of the aneurysms in relation tothe clivus and
b. Medio-lateral location, along with the course of the artery. High riding aneurysms may be reached by the orbito –zygomatic approach, although this approach is limited by the need to perform posterior clinoidectomy. This may cause morbidities related to cranial nerve paresis.

An alternative method that may be selected for high riding AICA aneurysms would be a sub-temporal middle fossa approach with divisions of the tentorium combined with petrosectomy as popularized by Drake and colleagues14. In addition to the removal of petrous apex, the use of sub- temporal transtentorial approach involves opening the tentorial edge, posing hazard to cranial nerve IV 13.Theretrosigmoid route with or without partial petrosectomy is the simplest and straight forward way to expose AICA region. The retrosigmoid approach can be combined with either a medical petrosectomy in high riding aneurysmsor a farlateral approach when required to expose low lying aneurysmsnear vertebro basilar junction 16,17.

Tr an s p e t r o s al ap p r o ac h e s ( Tr an s c o c h l e ar an d translabyrinthine) provide the most direct route to the brain stem 18,19,20,21. However these approaches are associated with significant morbidity, such as deafness, facial nerve palsy and CSF leakage and are rarely performed in the absence of giant AICA aneurysms. The supratentorial-infratentorial presigmoid approach allows various degrees of resection involving the semicircular canals, vestibule and cochlea. Transoral transfacial approaches to AICA aneurysms have been reported but are not routinely used because of their high morbidities22,23.

**CONCLUSIONS**

Aneurysms of AICA are veryrare, only47 casesare reported in literature. They present with clinical features pertaining to sub-arachnoid hemorrhage like sudden headache, Vomiting, loss of consciousness, seizures. CT scan brain reveals SAH,IVH, DSA of cerebral vessels detects the aneurysms. 3 D- CT angiography of brain with superimposed bony windows give a clear delineation with bones and internal auditory meatus. Microsurgical and endovascular modalities of treatment achieve similar outcomes. Complications ofmicrosurgical treatment are VII/VIII cranial nerve palsycerebellar symptoms.

One variety of AICA aneurysm is “AICA-PICA Variant” where agenesis of the PICA leads to a well-developed AICA so that it can supply the areas that would have been perfused by the absent vessels. The special concern in the variety is that, the distal ow should be preserved while treating the aneurysm either be microsurgical or endovascular means as a large anatomical area is supplied by a single artery.

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