# Multimodality Treatment of Posterior Inferior Cerebellar Artery Aneurysms

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■ OBJECTIVE: **Posterior inferior cerebellar artery (PICA) aneurysms are heterogeneous, uncommon lesions that can be treated in many fashions. Many previous series have focused on a specific aneurysm subset or treatment paradigm. The aim of this study was to present a comprehensive approach for all PICA aneurysms and analyze outcomes by PICA location.**

■ METHODS: **All PICA aneurysms treated from 2012 until present were reviewed retrospectively and classified by location. Angiographic and clinical outcome were assessed.**

■ RESULTS: **We identified 30 patients (average age 56 years, female 76.7%, subarachnoid hemorrhage 83.3%) with 30 aneurysms (saccular 50.0%) who underwent 36 treatments. Locations included the vertebral artery–PICA junction: 8; anterior medullary (AM): 7; lateral medullary: 3; tonsillomedullary: 1; telovelotonsillar: 5; and cortical: 6. Treatments included clipping: 6; trapping: 2; coiling: 13; balloon-assisted coiling: 1; stent-assisted coiling: 1; flow diversion: 1; and endovascular parent vessel occlusion: 6. There were 3 procedural complications. Recurrence and retreatment rates were 23.3% and 20.0%, respectively. Retreatments included coiling: 1; clipping: 4; and bypass: 1. Seven patients had an associated cerebellar arteriovenous malformation, of whom 5 have undergone resection. Good clinical outcome was achieved in 43.3% at discharge and 84.6% at follow-up (average 10.7 months). Aneurysms distal to the AM segment were more likely to occur in older patients ($P = 0.007$), with cerebellar arteriovenous malformations ($P = 0.031$), and to be treated with parent vessel occlusion ($P = 0.001$). Recurrences were more common for AM segment aneurysms ($P = 0.016$). Poor outcome was associated with poor SAH grade ($P = 0.010$), not aneurysm morphology ($P = 0.356$), location ($P = 0.867$), or treatment type ($P = 0.365$).**

■ CONCLUSIONS: **Our 5-year modern experience highlights the diversity of PICA aneurysms and the need for multimodality paradigms to treat them successfully. The AM segment has the greatest rate of recurrence. Aggressive management is warranted given that the majority of patients can have a good neurologic outcome.**

## INTRODUCTION

Posterior inferior cerebellar artery (PICA) aneurysms are uncommon lesions that account for approximately 0.5%–3% of all intracranial aneurysms.[1,2] They are highly diverse, and their sites of origin span from the vertebral artery–posterior inferior cerebellar artery junction (VPJ) to anywhere along the length of the PICA (Figure 1). They may be saccular, dissecting, or fusiform. They may be treated with a

**Key words**
- Aneurysm
- Clipping
- Coiling
- PICA

**Abbreviations and Acronyms**
AM: Anterior medullary
AVM: Arteriovenous malformation
BAC: Balloon-assisted coiling
CN: Cranial nerve
FD: Flow diversion
LM: Lateral medullary
mRS: Modified Rankin Scale
PICA: Posterior inferior cerebellar artery
PVO: Parent vessel occlusion
SAC: Stent-assisted coiling
SAH: Subarachnoid hemorrhage
TM: Tonsillomedullary
TVT: Telovelotonsillar
VPJ: Vertebral artery–posterior inferior cerebellar artery junction

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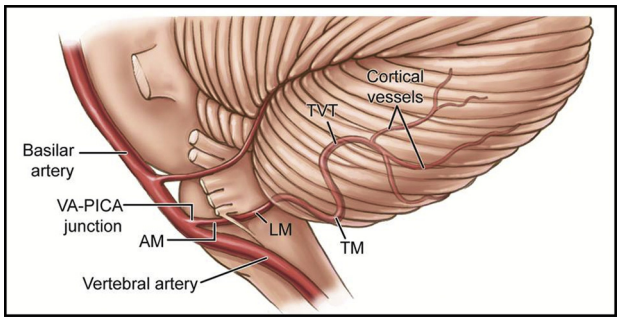


**Figure 1.** Posterior inferior cerebellar artery (PICA) anatomy and aneurysms. The PICA anatomy is demonstrated, including the vertebral artery-PICA junction followed by the 5 segments: anterior medullary (AM), lateral medullary (LM), tonsillomedullary (TM), telovelotonsillar (TVT), and cortical branches (CB). Figure by Jill Gregory. Printed with permission of Mount Sinai Health System, licensed under CC BY-NC-ND.

broad range of microsurgical and endovascular techniques. Although there have been a number of published PICA aneurysm series, frequently these series focus on only one population of PICA aneurysms (e.g., distal segment) or only one treatment modality (e.g., endovascular therapy).[3-29] Our modern series highlights the variety of treatment modalities available, the efficacy of these treatments for specific aneurysm locations, and the importance of treating complex aneurysms at an academic center with specialists in open cerebrovascular, endovascular, and neurointensive care.

## METHODS

After approval from the Mount Sinai Health System institutional review board, a retrospective review of aneurysms treated over the 5-year period from April 2012 to April 2017 disclosed 30 patients with 30 PICA aneurysms who underwent 36 interventions. A waiver of consent was obtained to perform this retrospective review. Demographic information was obtained from the electronic medical record. Mode of presentation was recorded for all aneurysms and correlated with clinical presentation and outcome. Concurrent medical conditions such as trauma, connective tissue disease, and drug use were recorded. Hunt and Hess score was used for subarachnoid hemorrhage (SAH) grade, and poor grade was defined as IV and V. All patients with SAH received standard neurosurgical management in the intensive care unit for at least 2 weeks.

Aneurysms were evaluated on digital subtraction angiography. By location, aneurysms arising at the VPJ and aneurysms arising within the 5 segments of PICA (Figure 1): anterior medullary (AM), lateral medullary (LM), tonsillomedullary (TM), telovelotonsillar (TVT), and cortical branches were included in the study group. Aneurysms of the VPJ and AM segment were defined as proximal and all others distal.[14] By type, aneurysms accepted into the study group included saccular and atypical (e.g., fusiform and dissecting) aneurysms, and feeding artery aneurysms associated with cerebellar arteriovenous malformations (AVMs). Intranidal aneurysms were excluded from the study. Aneurysm sizes were measured in 3 dimensions at the time of treatment and recorded in the operative report. The side and origin of the affected PICA with respect to the dura were noted in each case.

For each aneurysm, the treatment type and any procedural complications were determined from the operative reports. Treatment for a given aneurysm was based on consensus opinion from members of a comprehensive cerebrovascular team, consisting of neurosurgeons, neurologists, neuroradiologists, and intensive care specialists. Except in emergency situations, cases typically were presented during a daily conference, and treatment was decided after an open discussion of risks, benefits, and alternatives of each treatment modality. For patients who underwent parent vessel occlusion (PVO), postoperative magnetic resonance imaging and computed tomography were evaluated for ischemia in the PICA territory. The extent of initial aneurysm occlusion was graded by use of the 3 step Raymond scale[30]: Grade 1 (complete aneurysm occlusion), Grade 2 (residual aneurysm neck), and Grade 3 (residual aneurysm dome). Follow-up information included any evidence of aneurysm recurrence, any need for retreatment and the type of retreatment selected. Clinical outcome was retrospectively derived from the electronic medical record based on the Modified Rankin Scale (mRS). Poor outcome was defined as mRS 3–6.

Data for PICA aneurysms were assessed by location, angiographic outcome, and clinical outcome. Comparisons were made between the following patient groups: 1) proximal versus distal PICA aneurysm, 2) nonrecurrent versus recurrent, and 3) good versus poor clinical outcome. Continuous variables are presented as mean ± SD and were compared between groups with the use of Student $t$ tests. Categorical variables were compared between groups with $\chi^2$ tests. The Mann-Whitney U test was used to compare age between groups. All reported $P$ values are 2-sided with $\alpha = 0.05$. Statistical analyses were performed with the R language for statistical programming (R Foundation for Statistical Computing; Vienna, Austria).

## RESULTS

The final study group included 40 patients with 40 PICA aneurysms who underwent 36 separate treatments (Table 1). Most patients were female (76.7%). The average age at presentation was 56 years. Most patients (83.3%) presented with SAH. Other presentations included incidental imaging finding ($n = 4$), and positive family history ($n = 1$). The majority of patients with SAH (72%) had an initial good Hunt and Hess score (I–III). Concurrent cerebellar ICH was present in 24% of cases. No patients had a history of trauma, connective tissue disease, or drug abuse that would predispose to non-saccular aneurysm formation.

The origins of the PICA aneurysms were widely distributed (Table 2; Figures 2–7)[31]: VPJ: 8, AM: 7, LM: 3; TM: 1; TVT: 5; and cortical branches: 6. There was an equal distribution of saccular versus atypical aneurysms: 15 (50%) were saccular in morphology, 14 (46.7%) were fusiform, and 1 (3.3%) was a dissecting aneurysm. Nonsaccular morphology was associated with presence of a cerebellar intracranial hemorrhage ($P = 0.006$). Seven aneurysms (23.3%) were inflow aneurysms situated along segments of PICA feeding cerebellar AVMs. There was a near-equal distribution of left (46.7%)- and right (53.3%)-sided