# Distal Posterior Inferior Cerebellar Artery Aneurysms: Clinical Features and Outcome of 80 Patients

*Hanna Lehto, Ali Harati, Mika Niemelä, Reza Dashti, Aki Laakso, Ahmed Elsharkawy, Jarno Satopää, Romain Billon-Grand, Bruno Canato, Riku Kivisaari, Juha Hernesniemi*

**Key words**
- Cerebral aneurysm
- Microsurgery
- Posterior inferior cerebellar artery
- Vertebral artery

**Abbreviations and Acronyms**
AVM: Arteriovenous malformation
95% CI: 95% confidence interval
H&H: Hunt and Hess
IVH: Intraventricular hemorrhage
OA: Occipital artery
OR: Odds ratio
PICA: Posterior inferior cerebellar artery
SAH: Subarachnoid hemorrhage
VA: Vertebral artery

*From the Department of Neurosurgery, Helsinki University Central Hospital, Helsinki, Finland*

*To whom correspondence should be addressed: Hanna Lehto, M.D. [E-mail: hanna.lehto@hus.fi]*

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OBJECTIVE: **Aneurysms of the posterior inferior cerebellar artery (PICA) distal to its origin are rare. Beside their rarity, their treatment is challenged by a high proportion of fusiform aneurysms, torturous course of PICA, and often severe bleeding. Our aim is to represent the characteristics of these aneurysms and their treatment, as well as to analyze outcome.**

METHODS: **We reviewed retrospectively 80 patients with PICA aneurysms who were treated at the Department of Neurosurgery, Helsinki, Finland.**

RESULTS: **The 80 patients had altogether 91 distal PICA aneurysms. Subarachnoid hemorrhage occurred in 74 (93%), and the distal PICA aneurysm was ruptured in 68 (85%). Compared with aneurysms at other locations, distal PICA aneurysms were smaller, more often fusiform, and more often caused an intraventricular hemorrhage as well as rebleeding. Modified surgical techniques (trapping, wrapping, proximal occlusion, resection, coagulation) were used in 10 (32%) fusiform and in 3 (6%) saccular aneurysms. Revascularization was needed in 3 (4%) cases. One aneurysm was primarily embolized. Within a year after aneurysm diagnosis, 18 patients had died. Among survivors, most returned to independent or previous state of living: 52 (91%); only 1 patient was unable to return home.**

CONCLUSIONS: **Microsurgery is a feasible treatment for distal PICA aneurysms. Despite the challenge of often severe hemorrhage, wide-necked aneurysms, and some risk for laryngeal palsy, most patients surviving the initial stage return to normal life. Because of the greater number of rebleedings than for aneurysms at other locations, immediate treatment is crucial.**

## INTRODUCTION

Of all intracranial aneurysms, aneurysms in the posterior inferior cerebellar artery (PICA) distal to its origin comprise <1% of all intracranial aneurysms (25, 59). A highly variable and tortuous course of the parent artery with a various number of perforating branches originating from its proximal segments, in close relation to lower cranial nerves, deep location in the posterior cranial fossa, and a high proportion of fusiform and dissecting aneurysms make treatment of distal PICA aneurysms challenging. Compared with other intracranial aneurysms, distal PICA aneurysms rupture at a small size (20, 59) and have a greater rate of rebleeding (25). They often cause intraventricular hemorrhage (IVH) (25, 31, 48, 59) and hydrocephalus (26, 31, 48, 59). Despite high Hunt and Hess and Fisher grades, most patients ultimately make a good recovery (20, 31, 48, 59).

In this study, we present a retrospective analysis of 80 consecutive patients with 91 distal PICA aneurysms and discuss typical anatomical and radiological features, clinical presentation, and treatment outcome. To our knowledge, this is the largest series of distal PICA aneurysms reported.

## PATIENTS AND METHODS

The study design was approved by the Ethics Committee of Helsinki University Central Hospital.

### Terminology and Classification of Distal PICA Aneurysms

PICA is defined here as the cerebellar artery originating from the vertebral artery (VA) (37, 52). Distal PICA aneurysms (true PICA aneurysms) are defined by their location on the PICA, outside the VA–PICA junction.

Distal PICA aneurysms are further subclassified according to their location on the parent artery. Drake et al. (15) divided them into those located on the first 1 cm of PICA (proximal) and distal ones. The aneurysms also can be classified into 5 subgroups according to segments of the parent artery: 1) anterior medullary, 2) lateral medullary, 3) tonsillomedullary, 4) telovelotonsillar, and 5) cortical (31, 37). On the basis of aneurysm morphology, we subdivided these aneurysms into saccular and fusiform, with aneurysms having their neck wider than their dome considered fusiform.

### Patient and Radiologic Data

We reviewed retrospectively 9709 consecutive patients with intracranial aneurysms

treated between 1934 and 2011 at the Department of Neurosurgery at Helsinki University Central Hospital, Finland. To ensure a population-based sample, we excluded patients referred from abroad, including a total of 80 patients harboring at least one distal PICA aneurysm. Aneurysms were identified either by conventional or digital subtraction angiography, by computed tomography angiography, by magnetic resonance angiography, by autopsy, or by surgery. Subarachnoid hemorrhage (SAH) was diagnosed by computed tomography (n = 67) or lumbar puncture (n = 7). Patients' neurologic status was assessed on the Hunt and Hess H&H) scale without the correction for general disease (22).

We compared patients with a ruptured distal PICA aneurysm with those with a ruptured aneurysm elsewhere (age, sex, number of aneurysms, aneurysm morphology and size, Fisher grade, IVH, intracerebral hemorrhage, H&H scale, and rebleeding rate). Data for comparison came from a database comprising all patients with intracranial aneurysms treated in our department between 1937 and 2009. We limited this part of the study to the years after 1980s, that is, the era of computed tomography scanning and microneurosurgery.

All imaging studies obtained after 1989 were available for review. In cases with images unavailable, or of poor quality or distorted, data came from radiologic and operative reports. We measured each aneurysm's maximum diameter and the diameter of its neck and pouch in 2 directions. We recorded all intracranial vascular pathologies as well as anatomical variations in the VA, cerebellar arteries, basilar artery, and also possible persistent fetal anastomoses. VAs $\leq$2 mm in diameter at the level of the foramen magnum we considered hypoplastic (49).

### Follow-Up Data

The patients were followed up until death or the end of 2011. Vital status on December 31, 2011, and the possible date of death came from the Population Registry Centre comprising all Finnish residents. Statistics Finland (http://www.stat.fi/index_en.html) provided cause of death. To all surviving patients, we sent a written questionnaire regarding their present health status. For those not responding to the query, we gained the follow-up data from the Department of Neurosurgery only. For those deceased, we sought medical records from all public health services.

### Statistical Analysis

We performed the data analysis by a commercially available statistical software (IBM SPSS Statistics, version 20.0.0 for Mac; SPSS Inc., Chicago, Illinois, USA). For comparison between different groups, we used Mann-Whitney U test for continuous, and Pearson's $\chi^2$ or Fisher exact test for categorical variables. For those operated on for a ruptured distal PICA aneurysm, we analyzed risk factors for death at 1 year. In univariate analysis we included age, sex, Fisher grade, size and morphology of the aneurysm, possible rebleeding, shunt-dependent hydrocephalus, and H&H grade in good (H&H 1–3) and poor (H&H 4–5) grade groups. To calculate odds ratios (ORs) and 95% confidence intervals (CIs) of independent factors associated with 1-year case fatality, we used unconditional binary logistic regression analysis. To a stepwise forward elimination procedure, selected variables were added on the basis of their probability values. Probability value $<$ 0.05 was statistically significant.

## RESULTS

### Patients

The 80 patients had altogether 91 distal PICA aneurysms. After year 2000, the era of computed tomography angiography and magnetic resonance angiography in our department, the prevalence of distal PICA aneurysms was 1.2% of all and 1.8% of the ruptured aneurysms. Among all patients with intracranial aneurysms, a distal PICA aneurysm was diagnosed in 1.4%.

Our first patient underwent surgery for a distal PICA aneurysm in 1962; 5 patients were diagnosed and treated before 1980, 6 between 1980 and 1989, 24 patients between 1990 and 1999, and the remaining 44 (55%) after 2000.

Of these 80 patients, 68 (85%) presented with SAH from a distal PICA aneurysm (**Table 1**). A comparison of the patients with a ruptured distal PICA aneurysm with patients with ruptured aneurysms elsewhere revealed no difference in sex or age distribution (**Table 2**).

**Table 1.** Patient Characteristics

| | |
|---|---|
| Age at diagnosis, years, median (range) | |
| Patients with SAH | 51 (17–77) |
| Patients without SAH | 58 (44–73) |
| Sex, n (%) | |
| Male | 32 (40) |
| Female | 48 (60) |
| Presentation, n (%) | |
| SAH from a distal PICA aneurysm | 68 (85) |
| SAH from another aneurysm | 6 (8) |
| Mass lesion | 2 (3) |
| Ischemia | 1 (1) |
| Ruptured AVM | 1 (1) |
| Asymptomatic | 2 (3) |
| Hunt & Hess grade; number of all patients (patients with a ruptured distal PICA aneurysm) | |
| 1 | 7 (6) |
| 2 | 13 (10) |
| 3 | 26 (25) |
| 4 | 16 (16) |
| 5 | 12 (11) |

SAH, subarachnoid hemorrhage; PICA, posterior-inferior cerebellar artery; AVM, arterio-venous malformation.

### Aneurysms

**Table 3** presents the characteristics of the 91 distal PICA aneurysms in ruptured and unruptured groups. Most aneurysms in both groups were $<$ 7 mm in size; a greater proportion of the ruptured aneurysms were located in the medullary segments of PICA. Among the 52 saccular aneurysms, in a hairpin curve of the artery we located 20 (38%), and at the branching point, 5 (10%) aneurysms. No data were available for 7 (13%). See **Figure 1** for typical distal PICA aneurysms.

### Variations in Vascular Anatomy

Multiple aneurysms were diagnosed in 21 (26%) patients (**Table 4**). Seven patients (9%) had multiple distal PICA aneurysms; none were bilateral distal PICA aneurysms. Five patients (6%) had an additional arteriovenous malformation (AVM; **Figure 2**).

Angiographies for measuring the VAs were available for 67 (84%) patients: a hypoplastic VA was diagnosed in 28 (42%). No correlation appeared between