A Case of Ruptured Distal Posterior Inferior Cerebellar Artery Aneurysm Treated with Intra-aneurysmal Coil Embolization

Takashi Mizowaki,1 Atsushi Fujita,2 Te Jin Lee,1 Satoshi Inoue,1 Ryuichi Kuroda,1 Seishirou Urui,1 Eiji Kurihara,1 and Eiji Kohmura2

Objective: We report a case wherein coil embolization with an intention to preserve the hemispheric branches was performed to treat a ruptured saccular aneurysm in the distal posterior inferior cerebellar artery (PICA) during the acute period. The considerations that led to the selection of the endovascular treatment are discussed.

Case Presentation: The patient was an 87-year-old woman who presented with subarachnoid hemorrhage. After considering the patient’s age and the severity of her condition, intra-aneurysmal coil embolization was performed to treat a saccular aneurysm in the left telovelotonsillar segment. The parent artery was preserved, and no postoperative complications were noted.

Conclusion: Either parent artery embolization or intra-aneurysmal embolization should be selected as the endoscopic treatment methodology for de novo saccular aneurysms located in the PICA, except for those in the vertebral artery bifurcation area. The treatment selection should be based on careful evaluation of the aneurysm size, parent artery diameter, and aneurysm site.

Keywords: distal posterior inferior cerebellar artery, subarachnoid hemorrhage, coil embolization

Introduction

Apart from those that occur in the vertebral artery bifurcation area, intracranial aneurysms that occur in the posterior inferior cerebellar artery (PICA) are rare, accounting for ≤3% of all cerebral aneurysms.1-16) The number of reports on the use of endovascular treatments for PICA aneurysms has increased recently; however, an endovascular procedure should be selected after individual patient assessment as the PICA has several anatomical variations, has a small diameter, and has considerable tortuosity. In the case presented here, we treated a distal PICA aneurysm accompanied by subarachnoid hemorrhage by performing intra-aneurysmal coil embolization while preserving the parent artery. Several endovascular treatments and procedures were evaluated by comparing our case with other PICA aneurysm cases in the literature after excluding cases of aneurysms at the vertebral artery bifurcation area.

Case Presentation

The patient, an 87-year-old woman, presented with consciousness disturbance. She had a history of hypertension, atrial fibrillation, heart failure, and hypothyroidism.

One day, as she stood up to go to the toilet at home, she felt sick, vomited, and gradually started losing consciousness; she was then immediately taken to the hospital. On admission, her level of consciousness was Japan Coma Scale 200 and Glasgow Coma Scale 5 E1V2M2, and the severity of subarachnoid hemorrhage was Hunt and Hess
grade V and World Federation of Neurological Surgeons grade V. The pupil diameter was bilaterally 2 mm, and light reflex was slow.

**Imaging findings**

Head CT scans showed many subarachnoid hematomas in the posterior cranial fossa and marked intraventricular hematomas primarily in the 3rd and 4th ventricles, suggesting acute obstructive hydrocephalus (Fig. 1A and 1B). On 3D-CTA a saccular aneurysm (maximum diameter, approximately 10 mm) was noted in the left distal PICA (Fig. 1C), and no other abnormalities that could cause bleeding were noted elsewhere. Furthermore, no filling defect suggestive of a thrombotic aneurysm was noted in the aneurysm (Fig. 1D). On left vertebral artery angiography, a narrow-neck saccular aneurysm (12.9 × 6.8 mm) accompanied by a bleb was observed at the end of the telovelotonsillar segment of the left PICA (Fig. 2A). Although stenosis was observed in the region immediately adjacent to the aneurysmal neck in the parent artery on 3D-rotational angiography (3D-RA) (Fig. 2B), atherosclerosis was considered to be the cause of the aneurysm given the patient’s age and the absence of findings suggestive of dissection, such as double lumen and the pearl-and-string sign on either side of the stenosed area. Distal to the aneurysm, bifurcation of a cortical branch of the cerebellar artery was noted.

**Endovascular treatment**

A diagnosis of ruptured distal PICA aneurysm was made. Considering the age of the patient and the severity of the subarachnoid hemorrhage, endovascular treatment, which is a less invasive method, was selected. Moreover, because the parent artery was relatively thick and the lesion was a relatively large saccular aneurysm with a narrow neck, we decided to perform intra-aneurysmal coil embolization aimed at preserving the PICA trunk and hemispheric branches. Emergency surgery was performed on the day of the onset. Under general anesthesia, a guiding catheter 5 Fr Envoy STR (Cordis, Miami Lakes, FL, USA) was placed in the left vertebral artery via the right femoral artery. Systemic heparinization was initiated to adjust the activated clotting time to approximately 1.5 times the baseline value. Led by a microguidewire Traxcess 0.014 (MicroVention; TERUMO, Tokyo, Japan), a microcatheter Excelsior SL10 preshaped to 45° (Stryker, Kalamazoo, MI, USA) was guided into the aneurysm. The microcatheter movements...
were restricted due to the tortuosity of the parent artery and the stenosis immediately before the neck; however, a cage was prepared using Target XL360 (7.0 mm × 30 cm) (Stryker) as the first coil. Then, the aneurysm was filled serially with Target 360 soft (6.0 mm × 10 cm), 360 ultra (5.0 mm × 10 cm), 360 ultra (4.0 mm × 8 cm), and 360 ultra (3.0 mm × 6 cm). After observing dome filling and disappearance of the bleb, the intra-aneurysmal coil embolization was stopped, and preservation of the peripheral branches of the PICA distal to the aneurysm was confirmed (Fig. 2C). The source of bleeding was treated and therefore intra-aneurysmal embolization was considered to be complete. Heparin was neutralized with protamine, and ventricular drainage was performed immediately after the procedure. MRI performed on the 10th hospital day showed no diffusion-weighted imaging hyperintensities suggestive of acute infarction in the brain parenchyma. On the 33rd hospital day, a ventriculoperitoneal shunt was placed to treat a communicating hydrocephalus. Left vertebral artery angiography performed on the 52nd hospital day confirmed the disappearance of dome filling and clear delineation of the peripheral branches of the PICA distal to the aneurysm (Fig. 2D). Eventually, the patient was transferred to another facility in an apallic state (Glasgow Outcome Scale 2) on the 87th hospital day.

Discussion

Although a diagnosis of subarachnoid hemorrhage in an elderly patient was made, we suspected that acute obstructive hydrocephalus contributed to the severity of the disease17) and decided to treat our patient aggressively. Endovascular treatment was selected mainly because of its low invasiveness.

We searched PubMed to identify a series of three or more cases of endovascular treatment for saccular aneurysms localized in the PICA (Table 1). The general sites of PICA aneurysms are classified as follows: 1) the anterior medullary segment, 2) lateral medullary segment, 3) tonsillomedullary segment, 4) telovelotonsillar segment, and 5) cortical segment.1–16) On the basis of this classification, we evaluated the factors to be considered while selecting the treatment methodology.

Direct surgery and endovascular treatment

Because patients with ruptured aneurysms are likely to develop a hematoma in the 4th ventricle, their condition

<table>
<thead>
<tr>
<th>Reference</th>
<th>Location</th>
<th>Mean size (mm)</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mukonowashuro (2003)</td>
<td>AM LM TM TT C Selective coiling PAO</td>
<td>8 (100)</td>
<td>8</td>
</tr>
<tr>
<td>Bradac (2004)</td>
<td>6 (100)</td>
<td>1 (60)</td>
<td>1</td>
</tr>
<tr>
<td>Andreou (2007)</td>
<td>5 (100)</td>
<td>1 (60)</td>
<td>1</td>
</tr>
<tr>
<td>Isokangas (2008)</td>
<td>3 (100)</td>
<td>0 (60)</td>
<td>0</td>
</tr>
<tr>
<td>Song (2008)</td>
<td>3 (100)</td>
<td>0 (60)</td>
<td>0</td>
</tr>
<tr>
<td>Hong (2011)</td>
<td>7 (100)</td>
<td>0 (60)</td>
<td>0</td>
</tr>
<tr>
<td>Tokimura (2011)</td>
<td>3 (100)</td>
<td>0 (60)</td>
<td>0</td>
</tr>
<tr>
<td>Bacigaluppi (2013)</td>
<td>14 (100)</td>
<td>0 (60)</td>
<td>0</td>
</tr>
<tr>
<td>Crowley (2012)</td>
<td>2 (100)</td>
<td>0 (60)</td>
<td>0</td>
</tr>
<tr>
<td>Lin (2012)</td>
<td>2 (100)</td>
<td>0 (60)</td>
<td>0</td>
</tr>
<tr>
<td>Chalouhi (2013)</td>
<td>11 (100)</td>
<td>0 (60)</td>
<td>0</td>
</tr>
<tr>
<td>Shin (2014)</td>
<td>6 (100)</td>
<td>0 (60)</td>
<td>0</td>
</tr>
<tr>
<td>Sejkorová (2016)</td>
<td>3 (100)</td>
<td>0 (60)</td>
<td>0</td>
</tr>
<tr>
<td>Tang (2016)</td>
<td>13 (100)</td>
<td>0 (60)</td>
<td>0</td>
</tr>
</tbody>
</table>

*Exclude AM segment AN, it is the total of VA-PICA and AM segment aneurysm. The number of AM segment aneurysm is not described. ***Including proximal aneurysm. ****Including proximal aneurysm. AVM: arteriovenous malformation. PICO: posterior inferior cerebellar artery.
tends to get exacerbated if there is a rapid increase in posterior cranial fossa pressure. Conventional direct surgery is advantageous because the properties of the aneurysm can be directly examined, regardless of its location, and early decompression can be achieved by removing the hematoma and draining the cerebrovascular fluid during the surgery. However, one study reported that aggressive treatment for hydrocephalus via ventricular drainage before endovascular treatment resulted in favorable outcomes. Another study that compared direct surgery and endovascular treatment reported that the factors related to poor outcomes were the severity of the subarachnoid hemorrhage and the presence or absence of acute hydrocephalus, and they reported that there was no difference in the outcomes between direct surgery and endovascular treatment. Our patient also showed a rapid decline in the level of consciousness accompanied by marked intraventricular hematoma after rupture, suggestive of a rapid increase in posterior cranial fossa pressure, as described in previous reports. In addition, Sejkorová et al. reported that ruptured distal PICA aneurysms should be treated early after the onset because the re-rupture rate before treatment was found to be higher for these aneurysms as compared to aneurysms at other sites, such as supratentorial aneurysms. In the present case, considering the risk of hemorrhagic complications due to systemic heparinization during the endovascular treatment, we performed ventricular drainage after the endovascular treatment. However, considering that our patient’s condition was very severe and she had intraventricular hemorrhage, performing ventricular drainage before endovascular treatment by prioritizing early control of the intracranial pressure could have been an alternative. According to a review of the literature concerning the use of direct surgery and endovascular treatment for PICA aneurysms after the year 2000, when the areas distal to the tonsillomedullary segment were regarded as the distal PICA, the complete occlusion rate was 95.5% by direct surgery and 92.5% by endovascular treatment; the recurrence rates were 1.1% vs. 8.9%, perioperative mortality rates were 8.9% vs. 4.1%, and postoperative cranial nerve disorder incidence rates were 8.8% vs. 5.1% in the direct surgery and endovascular treatment groups, respectively. The findings showed that, except for the recurrence rate, the outcomes of endovascular treatment were not inferior to those of direct surgery. However, the occlusion rate of the parent artery after the procedure (direct surgery vs. endovascular treatment; 8.4% vs. 41.3%) greatly contributed to the good neurologic outcome rate (direct surgery vs. endovascular treatment; 86.5% vs. 62.4%). These results suggest that endovascular treatment should be the first treatment of choice for patients in whom the parent artery can be preserved and those would benefit from the low invasiveness of the procedure.

Aneurysm size and treatment
Among studies that examined the relationship between aneurysm size and endovascular treatment, Bradac et al. observed that the risk of rupture of small-diameter aneurysms is high during intra-aneurysmal embolization due to “jumping” of the microcatheter caused by the tortuosity of the parent artery. In the present case, microcatheter manipulation was difficult, but because the aneurysm was relatively large and had a narrow neck, the risk of perforation by the microcatheter was relatively low, allowing safe treatment with preservation of the parent artery.

Location of the aneurysm and treatment
The distribution of the aneurysm sites varied among reports. Table 1 shows the data of patients, from reports in Table 1, for whom the sites of the saccular aneurysms and the endovascular procedures used were clearly stated. Fewer patients had aneurysms in the distal PICA. One of the reasons for this could be the fact that the patients included those who were excluded from endovascular treatment because the guiding of the microcatheter to the lesion and controlling of the microcatheter at the lesion were expected to be difficult due to the thinness of the parent artery, and the other reason could be the general rarity of cortical segment aneurysms. The number of patients who underwent intra-aneurysmal embolization with preservation of the parent artery was higher, and when aneurysms were classified into those in/proximal to the tonsillomedullary segment and those in/distal to the telovelotonsillar segment, no clear difference was observed in the selected procedure according to the site. This suggests that the site of aneurysm per se may not have been a factor that affected the selection of the endovascular treatment procedure. However, there could be cases in which endovascular treatment was attempted but could not be completed. Chalouhi et al. compared 54 patients who underwent endovascular treatment for proximal PICA aneurysms at sites up to the anterior medullary segment, including 22 patients with vertebral artery-PICA aneurysms and patients with PICA aneurysms distal to the anterior medullary segment. According to their report, the endovascular treatment failure rate was higher for distal aneurysms than for proximal
aneurysms (3.7% vs. 13.6%). The causes of failure were inability to guide the microcatheter into the aneurysm due to the thinness and tortuosity of the PICA, inability to place coils in the aneurysm, and instability of the microcatheter in the aneurysm. Therefore, it must be noted that aneurysms in the distal segments of the PICA may be poor indications for endovascular treatment because they would be difficult to access with a microcatheter.

Ischemic complications
It is difficult to perform adjunctive techniques for distal PICA aneurysms because of the thin and markedly tortuous parent artery. If preservation of the parent artery is necessary, embolization aimed at occluding the rupture site, including the bleb, is considered adequate treatment in the acute period in patients with a relatively large aneurysm in which the rupture point is easy to predict, as in the case of our patient. However, the preservation of thin parent arteries is difficult in the case of wide-necked or fusiform aneurysms, and the parent artery may be simultaneously or intentionally occluded with the aneurysm. With regard to ischemic complications that could occur if the parent artery cannot be preserved, a study reported that after performing intra-aneurysmal embolization in three of five patients with distal PICA aneurysms, no issues with blood flow in the distal PICA were noted during the procedure; however, asymptomatic parent artery occlusion was observed in two of these patients on follow-up cerebral angiography performed 6 months later. Another study that reported on the outcomes of parent artery embolization in six patients with aneurysms in the telovelotonsillar segment described satisfactory outcomes in all six patients, with the exception of two patients who developed asymptomatic cerebellar infarction. With regard to the possibility of cerebellar infarction in the PICA region due to parent artery occlusion, a number of reports have stated that fatal infarction can be frequently avoided due to leptomeningeal anastomoses. Furthermore, there are a few perforating branches distal to the tonsillomedullary segment that supply the brainstem, and the risk of brain infarction in aneurysms at this site is relatively low, even when the parent artery is occluded. Based on these findings, when considering endovascular treatment for distal PICA aneurysms, intra-aneurysmal embolization would most suitable for aneurysms in the anterior medullary, lateral medullary, and tonsillomedullary segments to achieve the preservation of penetrating branches; furthermore, parent artery embolization may be considered for aneurysms in the telovelotonsillar and cortical segments if preservation of the parent artery is difficult due to its vascular diameter or tortuosity. However, it is difficult to predict the occurrence of cerebellar and brainstem infarction due to parent artery occlusion even after performing the balloon occlusion test, and there are occasional instances of extensive brain infarction requiring decompressive craniectomy. Song et al. reported a case in which intra-aneurysmal embolization with preservation of the parent artery was performed for a ruptured aneurysm in the telovelotonsillar segment because the patient had serious neurologic symptoms. In our patient, the aneurysm was located in the telovelotonsillar segment, and the risk of perforating branch disorder due to parent artery occlusion was relatively low. However, as the condition was severe, the parent artery was relatively thick, and the lesion was a relatively large saccular aneurysm with a relatively narrow neck, we chose intra-aneurysmal coil embolization aimed at preserving the PICA trunk and hemispheric branches.

Recurrence
Although the treatment was completed in a mild dome filling state, thrombosis was thought to have occurred as a result of time-associated changes owing to the small diameter of the parent artery and the narrow neck. Chalouhi et al. reported that the recurrence rate after intra-aneurysmal embolization was 2.5 times higher for distal aneurysms as compared to proximal PICA aneurysms, and they ascribed the high recurrence rate to incomplete embolization during the initial treatment. In the present case, a neck remnant was

<table>
<thead>
<tr>
<th>Location</th>
<th>Total</th>
<th>Selective coiling</th>
<th>PAO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior medullary segment</td>
<td>25</td>
<td>21</td>
<td>4</td>
</tr>
<tr>
<td>Lateral medullary segment</td>
<td>21</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>Tonsillomedullary segment</td>
<td>13</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>Telovelotonsillar segment</td>
<td>20</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>Cortical segment</td>
<td>5</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

PAO: parent artery occlusion; PICA: posterior inferior cerebellar artery
intentionally left behind, and careful follow-up should be carried out.

## Conclusion

We describe a case in which intra-aneurysmal coil embolization was performed to treat a ruptured distal PICA aneurysm. Because the aneurysm was relatively large and had a relatively thick parent artery and a narrow neck, intra-aneurysmal coil embolization along with preservation of the parent artery could be performed in the acute period without complications. For the endovascular treatment of saccular aneurysms arising in the PICA, except in the vertebral artery bifurcation area, either parent artery embolization or intra-aneurysmal embolization can be selected. The procedure should be selected after carefully evaluating the aneurysm size, parent artery diameter, and site of the aneurysm.

## Disclosure Statement

There are no conflicts of interest to disclose.

## References