Clinical Article
Three-dimensional CT angiography for the surgical management of the vertebral artery-posterior inferior cerebellar artery aneurysms

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Summary

Background. Surgery of vertebral artery-posterior inferior cerebellar artery (VA-PICA) aneurysms is not easy because there is a close anatomical relationship between aneurysms and the surrounding neurovascular structures, and bony structures in the lateral foramen magnum. The preoperative evaluation for a circumstantial comprehension of anatomical relationships is very important for the surgical treatment of the VA-PICA aneurysms. Our experience in using three-dimensional CT angiography (3D-CTA) for the surgical management of VA-PICA aneurysms is herein reported.

Methods and findings. We successfully performed neck clipping in 5 cases of VA-PICA aneurysm using 3D-CTA. On 3D reconstructed images, we could see the characteristics of the aneurysms such as their relationships to the jugular tubercle and hypoglossal canal, the projecting direction of the dome, and the configuration of the neck in each case. 3D-CTA also provided a clear surgical view as well as the relationships of the aneurysms to the VA and origin of the PICA. Based on such information, we selected the most appropriate surgical approach among the transcondylar fossa approach, the transcondylar approach, or the far lateral approach with a C1 laminectomy.

Conclusions. Since 3D-CTA demonstrates the surgical anatomy of VA-PICA aneurysms in detail, it is very useful for helping surgeons to select the optimal approach.

Keywords: 3D-CTA; aneurysm; vertebral artery; posterior inferior cerebellar artery; surgical approach.

Introduction

The surgical treatment of VA-PICA aneurysms is not easy because they are usually located deeply and are also closely associated with the lower brainstem and the caudal cranial nerves [1, 2, 17, 18]. Furthermore, the bony structure in the lateral foramen magnum such as the occipital condyle and jugular tubercle are obstacles during surgery [5, 15, 16, 23]. Choosing an appropriate surgical approach must be tailored to suit the needs of the individual patient [2, 4, 9, 10, 18].

Recently, computerized tomography (CT) technology with three-dimensional angiography (3D-CTA) performed with a helical CT scanner has been developed and used not only for diagnosis but also for selecting the optimal surgical approach for cerebrovascular lesions [6, 7, 14, 20, 21]. Some published studies have reported on the advantages of this modality in demonstrating the surgical images as well as detecting the characteristics of the aneurysms [3, 11, 12, 19, 22].

Since we had the opportunities to treat 5 cases of VA-PICA aneurysm surgically, we herein report the usefulness of 3D-CTA in the surgical management of aneurysms in this special area.

Materials and methods

From 1997 to 2002, we surgically treated 5 cases of saccular aneurysms at the VA-PICA junction. The age, sex, and the characteristics of the aneurysms of these patients are summarized in Table 1. Three of the 5 cases had a ruptured aneurysm while the remaining 2 had an unruptured one. They preoperatively underwent cerebral angiography and 3D-CTA examination by different types of CT using conventional techniques at 4 different affiliated hospitals. The three-dimensional reconstructed images were generated on purpose to evaluate a surgical
approach and to imitate intra-operative surgical views. On the images, we preoperatively examined relationships of the aneurysm to the jugular tubercle, the hypoglossal canal and the atlanto-occipital joint. We checked the distance from the aneurysm to the midline, the projecting direction of the dome, the configuration of the neck, and the adhering point of the dome. Regarding of the location of the aneurysm, we finally searched it separately by the following three factors: its height comparing the jugular tubercle and hypoglossal canal, its antero-posterior relationship to the hypoglossal canal and its distance from the midline. We also paid close attention to the sizes of the jugular tubercle and the posterior condylar canal. In all patients direct neck-clipping was successfully performed by one of the authors (T.M.). After surgery we revalued the guiding information obtained from 3D-CTA images in comparison with the operative findings. Surgeries in 2 of the 5 cases (Case 2, 4) were already reported elsewhere [17, 18].

**Results**

Concerning visualization of an aneurysm, 3D-CTA not only showed the aneurysm in all cases but also clearly demonstrated it in 2 of the 5 cases even when the angiography did not detect it clearly.

The three factors of the location, the projecting direction of the aneurysmal dome and the shape of the neck were clearly detected on 3D-CTA images in all cases (Table 1). One of the 5 aneurysms had its height above the jugular tubercle, 1 had it at the same level as the jugular tubercle, 2 had theirs almost at the same level as the hypoglossal canal, and 1 was below the hypoglossal canal. Three aneurysms were located anterior to the hypoglossal canal, 1 aneurysm at the same level of the canal and 1 aneurysm posterior to the canal. One aneurysm was located in the midline, but the remaining 4 were located near the jugular tubercle in the lateral portion of the foramen magnum. The aneurysmal dome had the following projecting direction: anterosuperior, anterolateral, superolateral, superior, postero-inferior. In 1 of the 3 ruptured cases the 3D-CTA demonstrated adhesion of the dome of the aneurysm to the anterior wall of the hypoglossal canal. As a surgical approach, the transcondylar fossa approach was utilized in 3 cases where the aneurysms were located above and close to the jugular tubercle. The transcondylar approach was used in 1 case where the aneurysm was located in the midline. In the remaining 1 case where the aneurysm was located postero-inferior to the hypoglossal canal, the far lateral approach with C1 hemilaminectomy was utilized for clipping.

**Illustrative cases**

**Case 1**

A typical case of an unruptured aneurysm. This 69-year-old woman underwent a brain examination because of headaches. MRI revealed a small abnormal flow void in the left posterior fossa region. MRA and conventional angiography demonstrated an unruptured aneurysm at left VA-PICA junction. The 3D-CTA confirmed a 5 mm saccular aneurysm at VA-PICA junction with its dome projecting anterosuperiorly (Fig. 1a). It also demonstrated the aneurysm to be located anterosuperior to the jugular tubercle (Fig. 1b). Therefore, the transcondylar fossa approach was utilized and the aneurysmal neck was uneventfully clipped (Fig. 1c). The patient was discharged without any neurological deficits.

**Case 3**

A case of a ruptured aneurysm showing the adhesive point. This 41-year-old woman had a subarachnoid hemorrhage (SAH). On admission, the patient complained of severe headache but did not show any neurological deficits. Conventional angiography done on the same day demonstrated a suspicious dilatation at the

<table>
<thead>
<tr>
<th>Case no.</th>
<th>Age, sex</th>
<th>Ruptured/unruptured</th>
<th>Location of aneurysm</th>
<th>Direction of dome</th>
<th>Surgical approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>69, F</td>
<td>unruptured</td>
<td>above jug. tub.</td>
<td>antero-superior</td>
<td>lateral T.C.F. app.</td>
</tr>
<tr>
<td>2</td>
<td>54, M</td>
<td>unruptured</td>
<td>same level of jug. tub.</td>
<td>antero-superior</td>
<td>lateral T.C.F. app.</td>
</tr>
<tr>
<td>3</td>
<td>41, F</td>
<td>ruptured</td>
<td>same level of hypoglossal c.</td>
<td>anterior</td>
<td>lateral T.C.F. app.</td>
</tr>
<tr>
<td>4</td>
<td>47, F</td>
<td>ruptured</td>
<td>same level of hypoglossal c.</td>
<td>antero-medial</td>
<td>midline T.C. app.</td>
</tr>
<tr>
<td>5</td>
<td>47, M</td>
<td>ruptured</td>
<td>below hypoglossal c.</td>
<td>posteroinferior</td>
<td>lateral Far lat. app. with C1 laminctomy</td>
</tr>
</tbody>
</table>

Table 1. Summary of cases with VA-PICA aneurysms undergoing 3D-CTA

**Notes:**
- Jug. tub: Jugular tubercle
- Hypoglossal c.: Hypoglossal canal
- T.C.F. app: Transcondylar fossa approach
- T.C. app: Transcondylar approach
- Far lat. app: Far lateral approach
- * Compared to the level of the jugular tubercle and hypoglossal canal
- ** Compared to the hypoglossal canal
- *** Compared to the midline