Usefulness of Preoperative Transarterial Feeder Embolization of Cerebellar Hemangioblastomas

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Objective: Preoperative transarterial feeder embolization (TAE) may contribute to the safe surgical removal of hypervascular tumors such as cerebellar hemangioblastomas (CHBs). We examined the usefulness of preoperative TAE of CHBs in our series.

Methods: We retrospectively analyzed the results of treatment in seven patients with CHBs who had undergone preoperative TAE and subsequent surgery in our hospital between 2005 and 2015 (four males and three females, mean age: 45 years).

Results: The embolized feeders consisted of the posterior inferior cerebellar artery in five patients, superior cerebellar artery (SCA) in one patient, and occipital artery (OA) in one patient. The embolic materials consisted of polyvinyl alcohol (PVA) in two patients, n-butyl-2-cyanoacrylate (NBCA) in four patients, and the combination of PVA and NBCA in one patient. Surgery was performed 1–4 days after embolization. The mean volume of intraoperative blood loss was 593 mL. In all patients, total surgical removal of the tumor was possible in the absence of non-autologous blood transfusion. Furthermore, embolic blood vessels could be identified during surgery in all patients, contributing to intraoperative orientation. Periprocedural complication related to TAE, cerebellar infarction related to embolic material migration into a normal blood vessel occurred in one patient (13%).

Conclusion: The results suggest that preoperative TAE of CHBs using NBCA contributes to a decrease in the volume of intraoperative blood loss, intraoperative orientation, and safe surgical removal of CHBs.

Keywords: preoperative feeder embolization, cerebellar hemangioblastoma

Introduction

Cerebellar hemangioblastomas (CHBs) are benign, accounting for 8%–12% of posterior fossa tumors. The radical cure may be achieved by total removal of the tumor.1,2 However, if residual tumor cells are present, CHBs may recur at a high probability; therefore, the postoperative topical recurrence rate is reportedly approximately 20%.3 Because the operating field of the posterior fossa is limited, intraoperative hemorrhage makes surgery difficult in some patients. Therefore, to achieve safe total removal of the tumor, adequate feeder treatment is the most important. Preoperative transarterial feeder embolization (TAE) by endovascular treatment may contribute to an improvement in the results of surgery,4 but serious complications associated with preoperative embolization have been reported.5–7 A consensus regarding the usefulness and safety has not been reached. In this study, we examined the usefulness of preoperative TAE of CHBs in our series.

Patients of 11 patients who had undergone surgical removal of CHBs in our hospital between January 2005 and December 2015, the patients were seven in whom this procedure was combined with preoperative TAE (four males and three females). Of these, one patient had a recurrent CHB. In the four excluded patients, preoperative embolization was not
performed for the following reasons: emergency surgery due to the exacerbation of hydrocephalus (one patient), anatomical difficulty in approaching the distal area of the feeder (one patient), and the risk of embolic-material migration into a normal blood vessel due to multiple feeders from peripheral blood vessels or risk of hemorrhagic complications related to incomplete embolization (two patients).

The mean age of the patients was 45 years (25–66 years). The mean tumor (cyst) diameter was 39 mm (20–52 mm). The tumors were located in the cerebellar hemisphere in five patients and cerebellar vermis in two patients. In all patients but one, tumor-related cerebellar symptoms or increased intracranial pressure was noted (Table 1). We retrospectively analyzed the results of TAE, surgical removal, complications, and neurologic prognosis in these seven patients, and examined the efficacy of preoperative TAE.

**Methods**

A 5 Fr or 6 Fr guiding catheter was introduced into an area adjacent to the vertebral artery feeder through the right femoral artery. Subsequently, a Renegade 18 (Stryker, Kalamazoo, MI, USA) with polyvinyl alcohol (PVA) or Excelsior SL-10 (Stryker) with n-butyl-2-cyanoacrylate (NBCA) was placed into a proper feeder. When it was difficult to select a proper feeder using a SL-10, a Marathon (eV3 Endovascular, Covidien, Plymouth, MN, USA) was used. After confirming the selection of a proper feeder using superselective angiography, an embolic material was infused to achieve feeder occlusion. Embolic materials used are PVA, 150- to 250-µm particles and/or NBCA diluted with lipiodol to a concentration of 33% or 50%. When adopting a platinum coil as an additional material, embolization was performed using a GDC coil (Stryker).

**Results**

**Preoperative TAE**

The results of preoperative TAE are shown in Table 2. The main feeders consisted of the posterior inferior cerebellar artery (PICA) in five patients, superior cerebellar artery (SCA) in one patient, and occipital artery (OA) in one

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**Table 1  Characteristic and background of patients**

<table>
<thead>
<tr>
<th>Case no.</th>
<th>Age/Sex</th>
<th>Location</th>
<th>Max diameter(^a) (mm)</th>
<th>Main feeder</th>
<th>Number of feeders</th>
<th>Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25/M</td>
<td>R-Cerebellar hemisphere</td>
<td>52 (29)</td>
<td>R-PICA</td>
<td>1</td>
<td>Cerebellar ataxia</td>
</tr>
<tr>
<td>2</td>
<td>37/F</td>
<td>Cerebellar vermis</td>
<td>20 (20)</td>
<td>R-SCA</td>
<td>1</td>
<td>Hydrocephalus</td>
</tr>
<tr>
<td>3</td>
<td>66/M</td>
<td>L-Cerebellar hemisphere</td>
<td>30 (24)</td>
<td>L-PICA</td>
<td>3</td>
<td>–</td>
</tr>
<tr>
<td>4</td>
<td>66/F</td>
<td>L-Cerebellar hemisphere</td>
<td>42 (36)</td>
<td>L-SCA</td>
<td>1</td>
<td>Cerebellar ataxia</td>
</tr>
<tr>
<td>5</td>
<td>38/M</td>
<td>Cerebellar vermis</td>
<td>50 (24)</td>
<td>Bili-PICA</td>
<td>3</td>
<td>Hydrocephalus</td>
</tr>
<tr>
<td>6</td>
<td>48/M</td>
<td>R-Cerebellar hemisphere</td>
<td>38 (18)</td>
<td>R-PICA</td>
<td>1</td>
<td>Cerebellar ataxia</td>
</tr>
<tr>
<td>7</td>
<td>39/F</td>
<td>L-Cerebellar hemisphere</td>
<td>45 (15)</td>
<td>L-PICA</td>
<td>1</td>
<td>Headache</td>
</tr>
</tbody>
</table>

\(^a\) shows nodule size. Bil: bilateral; L: left; OA: occipital artery; PICA: posterior inferior cerebellar artery; R: right; SCA: superior cerebellar artery

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**Table 2  Details of feeder embolization**

<table>
<thead>
<tr>
<th>Case no.</th>
<th>Embolized feeders</th>
<th>Post-embolized states</th>
<th>Used devices</th>
<th>Used materials</th>
<th>Complication</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>CO</td>
<td>5 Fr Envoy + Renegade 18</td>
<td>PVA150–250 µm, GDC US</td>
<td>–</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>CO</td>
<td>5 Fr Guider + Renegade 18</td>
<td>2 mm × 2 mm + GDC vortX 3/2</td>
<td>–</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>CO</td>
<td>5 Fr Launcher + SL-10</td>
<td>33% NBCA; GDC-10 US 2 × 4 + ED coil 1.5 × 3</td>
<td>–</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>CO</td>
<td>5 Fr Guider + Renegade 18</td>
<td>PVA 150–250 µm + 33% NBCA</td>
<td>–</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>PO</td>
<td>6 Fr Guider + SL-10</td>
<td>50% NBCA</td>
<td>–</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>CO</td>
<td>6 Fr FUBUKI + SL-10</td>
<td>33% NBCA</td>
<td>–</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>PO</td>
<td>5 Fr Slim Guide + SL-10, Marathon</td>
<td>33% NBCA</td>
<td>–</td>
</tr>
</tbody>
</table>

CO: complete occlusion; NBCA: n-butyl-2-cyanoacrylate; PO: partially occlusion; PVA: polyvinyl alcohol; 6 Fr Fubuki: Asahi Intecc, Aichi, Japan; ED coil: Kaneka Medix Corp., Osaka, Japan; Envoy: Cordis, Johnson & Johnson, Miami, FL, USA; SL-10: Excelsior SL-10, Stryker, Kalamazoo, MI, USA; GDC coil: Stryker, Kalamazoo, MI, USA; Launcher: Medtronic, Minneapolis, MN, USA; Renegade 18: Stryker, Kalamazoo, MI, USA; Slim Guide: Medikit co. ltd., Tokyo, Japan
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In whom preoperative embolization was considered due to non-superficial tumors or the existence of a feeder on the dorsal side of the tumor, the mean operation time was 410 minutes, and the mean volume of intraoperative blood loss was 547 mL.

A representative case is shown below:

Case 6. A 48-year-old male.

Present illness and neurologic findings: The patient consulted a previous clinic with a headache, which had gradually exacerbated for 3 months before the initial consultation. A right cerebellar tumor was indicated, and he was referred to our hospital for detailed examination and treatment. Neurologically, mild cerebellar ataxia and headache suggestive of increased intracranial pressure were observed. Neither his medical nor family histories were contributory, and there was no concomitant tumor.

Imaging findings (Fig. 1): brain MRI revealed a cystic mass, involving the right cerebellar hemisphere and measuring 38 mm in diameter, with a clear border. The tumor had a mural nodule measuring 17 mm, which was uniformly contrast-enhanced by gadolinium. Compression of the 4th ventricle and mild hydrocephalus were noted; these may have caused the symptoms.

Treatment course: After informed consent was obtained, preoperative TAE was performed to decrease the volume of intraoperative blood loss. Under local anesthesia, a 6 Fr FUBUKI (Asahi Intecc, Aichi, Japan) was introduced into the right vertebral artery through the right femoral artery. The vertebral angiogram showed a tumor stain fed by some branches of right PICA. An Excelsior SL-10 (Stryker) was placed to an area adjacent to the tumor. After confirming the absence of vessels branching to the normal brain tissue at the position, 33% NBCA was infused. At the beginning of NBCA reflux, the infusion was discontinued, and the microcatheter was removed. Confirmative angiography after embolization showed the disappearance of the tumor stain from the right PICA. Under median suboccipital craniotomy, patient. Furthermore, the number of feeders embolized was one in five patients, two in one, and three in one. As an embolic material, PVA had been primarily used in the early phase, and NBCA in the late phase. Coils had been used in the early-phase patients. In one patient, an ED coil (Kaneka Medix Corp., Osaka, Japan) was additionally used after the use of a GDC coil.

As an embolization-related complication, cerebellar infarction related to NBCA reflux into a normal cortical vessel developed after embolization through an area adjacent to the distal side of the cortical vessel bifurcation in one patient (13%), leading to cerebellar ataxia (Case 3).

Surgery

The results of surgery are shown in Table 3. Surgical removal of the tumor was performed 1–4 days after preoperative TAE. In all patients, total removal of the tumor was obtained. Embolized feeders could be identified during surgery, contributing to orientation. The mean volume of intraoperative blood loss was 593 mL (range: 55–1320 mL).

There was no patient requiring non-autologous blood transfusion. In one patient with cerebellar infarction as a complication related to TAE, the modified Rankin Scale (mRS) and Karnofsky Performance Status (KPS) scores deteriorated in comparison with the preoperative values. However, in the other patients, there was no deterioration of neurologic symptoms after surgery, and the post-treatment course was favorable. The mean volume of intraoperative blood loss in the NBCA-selected patients was slightly smaller than in the PVA-selected patients (394 vs. 865 mL, respectively, P = 0.25). There was no significant difference in the operation time between the two groups (393 vs. 339 minutes, respectively, P = 0.43). In two of four patients in whom preoperative embolization was not performed, both the tumor and feeder influx sites were present in the superficial layer; surgical removal may have been easy in the absence of preoperative TAE. In the other two patients, in whom preoperative embolization was considered due to non-superficial tumors or the existence of a feeder on the dorsal side of the tumor, the mean operation time was 410 minutes, and the mean volume of intraoperative blood loss was 547 mL.

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Table 3  Details of operations

<table>
<thead>
<tr>
<th>No.</th>
<th>Time to surgery* (days)</th>
<th>Operation time</th>
<th>Removal ratio</th>
<th>Blood loss (mL)</th>
<th>Blood transfusion†</th>
<th>Post-op. mRS</th>
<th>KPS score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>5 hr 30 min</td>
<td>Total</td>
<td>1320</td>
<td>–</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>5 hr 48 min</td>
<td>Total</td>
<td>410</td>
<td>–</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>7 hr 31 min</td>
<td>Total</td>
<td>520</td>
<td>–</td>
<td>2‡</td>
<td>70</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>9 hr 43 min</td>
<td>Total</td>
<td>850</td>
<td>–</td>
<td>4</td>
<td>40</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>7 hr 31 min</td>
<td>Total</td>
<td>250</td>
<td>–</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>5 hr 32 min</td>
<td>Total</td>
<td>750</td>
<td>–</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>5 hr 40 min</td>
<td>Total</td>
<td>55</td>
<td>–</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

*Interval from embolization to surgical operation. †Except autologous transfusion. ‡Related to the complication of transarterial feeder embolization. KPS: Karnofsky performance status; mRS: modified Rankin scale.
surgical removal was performed 4 days after TAE. The embolized feeder was confirmed in the early phase of surgery, contributing to intraoperative orientation. As hemorrhage from the cranial sinus was observed at the time of craniotomy, the volume of intraoperative blood loss was 750 mL, but there was no hemorrhage from the tumor. Total removal of the tumor could be readily and macroscopically conducted. Blood transfusion was not required. Histopathological diagnosis confirmed a CHB. The patient was discharged 11 days after surgery, with a mRS score of 0. During the 24-month postoperative follow-up, there has been no recurrence.

**Discussion**

There are various opinions regarding the usefulness and safety of preoperative TAE of CHBs. However, most studies for considering its usefulness/safety adopted granular embolic materials, such as PVA or Embosphere.\(^2,5,8\) Cornelius et al. reported hemorrhagic complications related to TAE of CHBs with Embosphere and speculated that particle-related occlusion of tumor emissary veins might cause hemorrhage.\(^2\) Furthermore, the visibility of granular embolic materials during infusion is unfavorable, so it is difficult to completely evaluate the extent of embolization or migration into a normal blood vessel.\(^9\) In addition, a study indicated that partial embolization with granular embolic materials did not contribute to the reduction of intraoperative complications or the improvement of functional prognosis.\(^7\)

On the other hand, recent studies reported that TAE with a liquid embolic material, NBCA, was useful as a preoperative procedure.\(^10,11\) Murai et al. retrospectively compared 10 patients who had undergone embolization using NBCA with 24 who had undergone embolization using PVA and reported that the incidence of complications in the former was lower than in the latter (10% vs. 37.5%, respectively).\(^10\) Furthermore, another study indicated that the volume of intraoperative blood loss in patients used NBCA for TAE of CHBs was significantly smaller than in those used PVA.\(^11\) In our series, the volume of intraoperative blood loss was also slightly smaller in the NBCA group. In Case 6, in which the volume of blood loss was large,
hemorrhage from the sinus at the time of craniotomy comprised the greater portion, and hemorrhage from the tumor site was only slight. In addition, preoperative embolization with NBCA slightly reduced the volume of intraoperative blood loss in comparison with non-embolized patients although there was a limit of comparison due to the small number of patients. Of our series, a complication occurred in one patient used NBCA, but complication-free embolization could be accomplished in the subsequent patients by placing a microcatheter to a more distal area and carefully infusing the embolic material. Thus, safer preoperative TAE can be performed by placing a microcatheter to the distal area of a normal blood vessel and adopting NBCA, of which the visibility is more favorable than that of PVA, considering small-volume NBCA reflux. Furthermore, even when conducting TAE targeting proximal occlusion in NBCA-selected patients, the volume of intraoperative blood loss may be reduced.

In all patients who underwent preoperative TAE, the main feeders embolized could be identified in the initial phase of surgery, contributing to intraoperative orientation. Sakamoto et al. also reported similar results.11) The early identification of embolized blood vessels may facilitate nodule-position identification in hypervascular tumors, shortening the duration of suboccipital surgery in a narrow operating field and reducing invasiveness.

As the limitations of this study, this was a retrospective study, and various biases may have been present with respect to the presence or absence of preoperative TAE. In the future, the results of treatment should be compared after adjusting conditions, such as tumor localization or size.

### Conclusion

Preoperative TAE of CHBs may contribute to the safer total removal of the tumor by decreasing the volume of intraoperative blood loss and facilitating nodule-position identification. Furthermore, the use of a liquid embolic material may facilitate safer, more accurate TAE.

### Disclosure Statement

There is no conflict of interest for the first author and coauthors.

### References