Endovascular embolization of paragangliomas: A safe adjuvant to treatment

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Abstract

Background and Purpose: Paragangliomas are tumors of neural crest origin commonly arising from the carotid body, vagal nerve, or jugular bulb. The definitive treatment for these tumors is surgical resection, often augmented with pre-operative embolization due their highly vascular nature. We present our experience examining the efficacy and safety of endovascular embolization of these rare tumors.

Methods: A review of patients diagnosed with paragangliomas who underwent pre-operative embolization over a 5-year period (2002-2007) was conducted. The tumor subtype, efficacy of embolization, method of embolization, and rate of complication were noted.

Results: A total of 38 patients underwent selective arterial embolization of their paraganglioma using polyvinyl alcohol (PVA) particles ranging in size from 100-1000 microns. The tumor subtypes treated were carotid body (n = 20), glomus vagale (n = 10), and glomus jugulare (n = 8). The average age at presentation was 44 years (range, 15-81). Twenty-two patients were female and sixteen were male. The most common artery embolized was the ascending pharyngeal branch of the external carotid artery. Post-embolization angiography revealed an average decrease in blood flow to tumor of 75%. With the exception of transient facial pain documented in 1 patient, there were no known complications from embolization.

Conclusions: The endovascular embolization of paragangliomas using PVA prior to surgical resection is a very safe and efficacious procedure that may reduce operative blood loss and associated morbidity.

Key words: paraganglioma, embolization, polyvinyl alcohol.

Introduction

Paragangliomas of the head and neck are tumors of the paraganglia which arise from neural crest progenitor cells.1 The three most common sites for them are the carotid body, the jugular foramen, and the vagus nerve.2 Numerous terms have been used to describe these tumors including glomus tumor, chemodectoma, endothelioma, perithelioma, sympathoblastoma, and fibroangioma.3 Paraganglioma is the current term used to describe these lesions which are subclassified based upon their location and neurovascular associations.

The primary treatment for paragangliomas has evolved from radiation to surgical where the goal of surgical treatment is complete resection.4 Due to the rich vascular nature of these tumors, preoperative embolization has been described as a useful adjuvant prior to surgery.5 We present our institution’s experience with the endovascular embolization of paragangliomas.

Methods

This study was approved by the Institutional Review Board of the Mayo Foundation. A database search was conducted for all patients diagnosed with paragangliomas of the head and neck for a 5-year period spanning 2002-2007. At our institution, all patients who advance to surgery undergo tumor pre-embolization one to two days prior to their procedure. Each of these patients were the subject of this study and were included in our analysis.

Patients that undergo endovascular embolization are done so awake. Transfemoral access is obtained and a 5 Fr sheath is placed. A 5 Fr diagnostic catheter is then advanced into the CCA on the side the tumor resides. A CCA injection is performed to ensure that there are no ECA to ophthalmic artery anastomoses present that could compromise the patient’s vision during embolization. The diagnostic catheter is then
placed into the ECA where angiography is performed to determine the arterial feeders of the tumor.

After completion of the diagnostic angiogram, a microcatheter is placed through the diagnostic catheter and advanced into selective branches of the ECA where selective arteriograms may be performed for improved tumor visualization. Particles of PVA are then mixed in a 1:1 ratio with contrast in a stainless steel bowl which is labeled and placed distant to pure contrast. Initially, a smaller particle size (150-250 microns) is used for embolization. Particles are placed in 1 ml syringes which are then attached to the microcatheter and injected in pulses that are synchronous with systole. If flow to the tumor does not diminish, larger particle sizes (up to 1000 microns) are incrementally selected until there is cessation of flow or reflux of contrast along the microcatheter. This technique is repeated for all branches that are large enough to accommodate the microcatheter. A final angiogram from the CCA is performed to evaluate the degree of embolization and ensure patency of the ICA circulation.

Quantification of the percent of tumor that was successfully embolized is based upon estimation by the interventionalist comparing angiograms before and after embolization. All patients are then admitted for observation with the intention to treat surgically within the next day or two. Neurologic exams are performed during the interim.

Results

A total of 38 patients underwent selective arterial embolization of their paraganglioma using PVA particles ranging in size from 100-1000 microns (Table 1). The tumor subtypes treated were carotid body (n = 20, Figure 1), glomus vagale (n = 10, Figure 2), and glomus jugulare (n = 8, Figure 3). The average age at presentation was 44 years (range, 15-81 years). Twenty-two patients were female and 16 were male.

The most common artery embolized was the ascending pharyngeal branch of the ECA. Other branches that were fre-

Table 1. Characteristics of the reported population of patients with paragangliomas.

<table>
<thead>
<tr>
<th>Number of Patients</th>
<th>38</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Age, yrs (range)</td>
<td>44 (15-81)</td>
</tr>
<tr>
<td>Gender F:M</td>
<td>22:16</td>
</tr>
<tr>
<td>Tumor Subtype</td>
<td></td>
</tr>
<tr>
<td>Carotid Body</td>
<td>20</td>
</tr>
<tr>
<td>Glomus Vagale</td>
<td>10</td>
</tr>
<tr>
<td>Glomus Jugulare</td>
<td>8</td>
</tr>
<tr>
<td>Percent Embolized (range)</td>
<td>75 (40-95)</td>
</tr>
</tbody>
</table>
The findings of this study show that preoperative embolization of cervical region paragangliomas is a very safe adjuvant to surgical resection. Particle embolization with PVA using the techniques described above dramatically reduced tumor vascularity. In this study, there were no neurological complications associated with the procedure with only one patient complaining of pain during the peri-procedural period.

The classic angiographic appearance of a paraganglioma is that of a hypervascular mass with robust feeding arteries and intense tumor blush. Across most studies, the most common feeding vessel is the ascending pharyngeal artery. With tumor growth, other sources of arterial supply are usually recruited from any number of branches originating off of the ICA, ECA, or posterior circulation.

Carotid body paragangliomas arise within the carotid body and characteristically splay the bifurcation of the CCA (Figure 1). As the tumor enlarges, it may encase the ECA or ICA but normally does not compromise flow through them. Involvement of the lower cranial nerves and adjacent tissues has been documented. Vagal paragangliomas arise from glomus tissue rests within the nodose ganglion and are typically located just above the carotid bifurcation. Angiographically, they compress the internal jugular vein and displace the carotid vessels.
anteriorly and medially (Figure 2). Glomus jugulare tumors are defined as arising from within the jugular foramen. Angiography reveals a tumor blush at the skull base with arterial feeders from the ECA, ICA, and/or posterior circulation (Figure 3).

Successful embolization hinges upon occlusion of all feeding vessels which, based upon prior studies, has shown to be high. An intentional delay of 1-2 days between embolization and surgery allows time for edema to resolve without providing time for reconstitution or recruitment of feeding arteries. Embolization is normally done using PVA with sizes ranging from 150 to 1000 microns; however, other agents are available such as alcohol conjugates, liquid embolics (glue) and gel foam. Coil occlusion of the ICA is reserved for cases in which the tumor is extensively supplied from, or infiltrates, the ICA.

Complications of preoperative embolization vary. Minor complications include fever and facial pain which are attributed to tumor ischemia and are usually transient. Major complications such as stroke may occur with the accidental introduction of embolic material into the vertebrobasilar system via the ECA or its anastomoses with the ICA. Cranial nerve palsies occur with inadvertent introduction of embolic material into the vessels which supply them or use of particles that are too small thereby preventing a meaningful anastomoses to them. Other documented risks include transient aphasia, carotid sinus syndrome, and catecholamine storm.

Our findings are not without limitations. Unlike other reported studies, we do not have a control group of non-embolized tumors to compare embolization efficacy as manifest by operative blood loss. The values that we reported for blood loss are consistent with those shown in other studies, realizing that estimations of operative blood loss have been shown to be grossly inaccurate. Furthermore, the diminution of blood supply to the tumors was estimated by the practitioner and carries the error of subjectivity. Our bias toward PVA as an embolic material may not completely address the efficacy and safety of other embolic materials.

Conclusion
The endovascular embolization of paragangliomas using PVA prior to surgical resection is a very safe and efficacious procedure that reduces operative blood loss and associated morbidity. Complications can be significantly reduced or even eliminated by scrutiny of the pre-embolization angiogram.

References


