

COMBINED PREOPERATIVE ONYX EMBOLIZATION AND PROTECTIVE INTERNAL CAROTID
ARTERY COVERED STENT PLACEMENT FOR TREATMENT OF GLOMUS VAGALE TUMOR: REVIEW
OF LITERATURE AND ILLUSTRATIVE CASE

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ABSTRACT

Objective: Surgical resection of complex glomus vagale tumors can be complicated by extensive blood loss and might require surgical sacrifice of an encased internal carotid artery.

Methods: A young patient presented with mass effect from glomus valage tumor. Computerized tomography angiography showed an encased internal carotid artery. Cerebral angiography demonstrated a highly vascular tumor. A literature review was performed for endovascular treatment options for neck tumors.

Results: Staged preoperative embolization of feeder arteries via internal maxillary artery, and thyrocervical trunk with Onyx was performed. A covered stent was implanted in the cervical internal carotid artery to the common carotid artery; this resulted in complete devascularization of the tumor with exclusion of external carotid artery from the circulation. This is followed by surgical resection of the tumor.

Conclusion: Preoperative embolization with Onyx decreased the amount of blood loss intra-operatively. The implantation of a covered stent in the cervical internal carotid artery through the common carotid artery contributed for further devascularization of the tumor bed, as well as provided a lumen continuity in case iatrogenic carotid injury is encountered intra-operatively.

Running title: Onyx/covered stent for Glomus Vagale

Keywords: Glomus tumor, Covered stent, Onyx, Preoperative embolization, paraganglioma

INTRODUCTION

Paragangliomas or glomus tumors are uncommon, usually benign neoplasms of the head and neck comprising about 0.6% of head and neck tumors and about 0.03% of all tumors ⁽¹⁾. They are highly vascular tumors, and usually surgical resection is complicated by excessive blood loss. Occasionally the internal carotid artery (ICA) may require sacrifice if the tumor encases it. With the advancement of the endovascular techniques, it is now standard practice to embolize those tumors preoperatively⁽²⁾. In this report we present a case of giant cervical paraganglioma treated with endovascular embolization using ethylene vinyl alcohol copolymer (Onyx[®], eV3, Irvine, CA) in addition to placement of a covered stent (Fluency, Bard Peripheral Vascular, Tempe, AZ) in the left ICA for vessel preservation, followed by surgical resection.

CASE REPORT

A 23 year old female patient was evaluated for an asymptomatic left sided neck mass enlarging over 2 years. On examination, there was an obvious palpable neck mass. There were no cranial nerve deficits. Further evaluation with contrast enhanced Computed Tomography (CT) and CT angiography (CTA) imaging showed a 4.8 x 2.6 x 11.1 cm enhancing mass in the carotid space extending from the jugular bulb superiorly to the carotid bifurcation inferiorly, encasing the ICA (Figure 1A). The mass displaced the left internal jugular vein anteriorly and laterally, and invaded the left parapharyngeal space displacing the left pharyngeal wall medially. Diagnostic cerebral angiography was performed to better delineate the vascular anatomy of the tumor; this showed a highly vascular tumor consistent with glomus vagale, with multiple feeders from branches of the left external carotid artery (ECA) (Figure 1B), left vertebral artery (VA) (Figure 1C), and the left thyrocervical trunk. The tumor blush appeared to be

surrounding the left ICA, with displacement of the ICA medially and anteriorly, although there was no decrease in its caliber.

Because of the encasement and possible infiltration of the ICA with tumor the likelihood of carotid sacrifice during surgical tumor resection was felt to be high. Although the patient passed a balloon test occlusion both clinically and radiographically, given her young age a carotid-preserving approach was preferred. A multidisciplinary team consisting of Otolaryngology (head and neck surgery), Neuro-otology, Vascular Neurosurgery and Endovascular Neurosurgery collaborated to treat the tumor by aggressive preoperative embolization, ICA preservation with covered stent, followed by surgical resection.

The patient underwent two sessions of embolization. The initial embolization session consisted first of treatment through ECA branches, where an Echelon-14 microcatheter (eV3, Irvine, CA) was placed in the left Internal Maxillary Artery (IMA) branches and ethylene vinyl alcohol copolymer (Onyx-34, eV3, Irvine, CA) was used to embolize the tumor bed. After aggressive 3 feeder embolization, two covered stents (Fluency stent, 6mm x60 mm, and 8mm x40mm; Bard Peripheral Vascular, Tempe, AZ) were placed off-label (Not FDA approved for cervical arteries) telescoping and spanning the ICA from cervical-petrous portion to the mid cervical CCA. This resulted in complete devascularization of the ECA feeders to the tumor, with flow preservation through the ICA (Figure 1D). Besides devascularization, the stent was placed to provide lumen continuity in case a portion of the ICA wall was violated during surgical resection. The patient was maintained on Aspirin 325 mg and Plavix 75 mg PO daily.

Five weeks later the patient was re-admitted for the second stage of embolization, and surgical resection. Repeat angiography showed patent covered stent and extensive feeders from the thyrocervical trunk. Feeders from the thyrocervical trunk were embolized using Onyx-34. During the embolization, the liquid embolic agent migrated retrograde through the muscular feeders of the left VA, and partially

compromised the flow in the vessel. In an effort to reduce the chance of thrombo-embolic complications from flow stagnation in the left VA, and to further devascularize the tumor, the VA was occluded using detachable coils. With Plavix stopped one week before, and while on Aspirin, the patient underwent modified radical neck dissection of the neck with mastoidectomy procedure to expose the superior aspect of the tumor. The tumor was resected in total, and the left ICA was preserved (Figure 1E). The left internal jugular vein and the vagus nerve were resected because of tumor invasion. Adventitia surrounding the ICA invaded with tumor was also resected. Pathology results were consistent with glomus vagale. Estimated blood loss was 500 cc; patient was transfused with 2 units packed red blood cells during the surgery. Postoperatively, blood flow within the left ICA was measured using quantitative magnetic resonance angiography (using NOVA software, VasSol Inc., Chicago, IL) and confirmed patency of the stent (277 cc/min) (Figure 1F). The patient remains neurologically stable 16 months after the surgery, with no new symptoms.

DISCUSSION

The role of preoperative embolization of head and neck tumors is well established⁽³⁻⁷⁾, and is aimed at reducing the blood loss and aid in dissection from surrounding neural structures during surgical resection. Early descriptions used primarily intra-arterial particulate material for embolization⁽⁸⁻¹⁰⁾. The two primary routes of embolization are direct arterial embolization with selective catheterization of feeding vessels or direct percutaneous injection of various materials^(6, 11). Materials used for intra-arterial embolization include microcoils, gelfoam, polyvinyl alcohol (PVA) which come in several particulate size ranges, n-butyl cyanoacrylate (n-BCA) glue liquid embolic agent (Trufill- Codman Neurovascular: Raynham, MA), and poly vinyl alcohol (Onyx- Ev3 Neurovascular: Irvine, CA). Only microcoils, n-BCA, and Onyx

would be expected to be permanent agents, so timing of surgical intervention within days to weeks is critical. The second route is direct percutaneous puncture of the tumor with embolization either with n-BCA or Onyx^(6, 11-13). A refinement of the technique includes protection of the internal carotid artery with a balloon catheter during injection^(12, 13). Table 1 shows reported case series of 5 or greater patients treated with embolization. With trans-arterial embolization, the blood supply to the tumor is cut down, but not completely, due to complex angio-architecture. Intra-tumoral injection is easier to access but does not fully overcome the complex vascular anatomy and multiplicity of the feeders, and is less controlled. The choice of the optimal embolic agent depends on operator comfort as well as hemodynamic and angio-architectural factors.

Controversy still exists in the otolaryngology literature with regard to the necessity of pre-operative embolization, especially for smaller tumors. No randomized data assess the risks of embolization compared to increased risks of bleeding, operative time, or neurovascular injury during surgery, though several case series establish an overall decreased blood loss during surgery with pre-operative embolization with a very low rate of complications from embolization^(2, 10, 14-22). (See Table 1).

Embolization carries a small risk of complication and must be balanced against the need for additional hemostasis and reduction in transfusion. Table 1 summarizes reported complications in series with pre-operative embolization for paraganglioma. Casasco et al reported the complications with n-BCA embolization including middle cerebral artery embolization and ophthalmic artery glue migration during embolization of neck tumors⁽²³⁾. Gobin et al⁽²⁴⁾ used Onyx to treat 18 patients with hypervascular lesions. Though there clearly some advantages over n-BCA in terms of depth of penetration and perceived increased control with slow injection and the ability to stop and start. Uncontrolled distal migration is, however, still possible, as evidenced by the entry of the material into the VA through muscular branches in

our case. Temporary balloon testing was not performed for the left VA prior to sacrifice, once the left VA was partially occluded with Onyx, we evaluated the posterior circulation filling from the right VA. The flow from the right VA was deemed sufficient, thus we performed a completion sacrifice of the left VA to decrease the risk of thromboembolic events.

In this patient we used trans-arterial Onyx injection as well as subsequent covered stent placement.. A similar strategy has been reported in order to restore caliber of a stenotic ICA from tumor^(25, 26), however in our case, the carotid itself was of normal pre-operative caliber. In large lesions where the carotid is thought to be at significant risk during resection, or where the carotid cannot be sacrificed such as contralateral occlusion⁽²⁶⁾, this may offer a degree of protection during surgery. The polytetrafluoroethylene (PTFE) portion of the covered stent provides a continuity of the vessel lumen (ICA) in case the vessel wall is violated during dissection, thus avoiding permanent carotid artery sacrifice.

An alternative use of covered stents that has been reported is the placement into the ECA itself to aid in devascularization^(27, 28). Tripp⁽²⁷⁾ reported one patient and Scanlon⁽²⁸⁾ reported three patients with carotid body tumors treated with preoperative devascularization with covered stents.

To our knowledge, this is the first reported use of a covered stent to preserve the normal ICA and to devascularize the tumor in the management of a neck paraganglioma, in conjunction with aggressive endovascular embolization and radical tumor resection. The Fluency covered stent is not FDA approved for cervical arterial use, and is used in this case as an off-label indication. We performed the procedure in multiple stages, first a diagnostic angiogram was done to delineate the vascular anatomy of the tumor along with a balloon occlusion test in case ICA sacrifice was needed. In the second stage ECA feeders were embolized with Onyx and covered stents were deployed to preserve the cervical ICA encased with the tumor, in the third stage the thyrocervical trunk feeders were embolized and left VA was sacrificed with

embolization, and in the fourth stage, the tumor was excised surgically. The patient was started on dual anti-platelet regimen before stent placement and was converted to single agent (aspirin) after 4 weeks in preparation for surgery. This combined multimodality approach was successful in preserving the ICA, reducing the blood loss during surgery and helping to delineate the ICA in the operative field. The main limitations of the use of covered stent include risk of delayed intravascular thrombosis, or in stent stenosis. The need for long-term anti-platelets therapy is a concern especially when the patient needs to undergo a major surgery with associated risk of bleeding. This did not seem to be a major problem in this particular case, since Plavix was withheld for one week prior to the surgical resection.

Conclusion:

A preoperative defined strategy of aggressive tumor embolization along with utilization of covered stent for flow preservation and tumor devascularization enabled an aggressive surgical resection of a glomus vagale in a young patient without sacrificing the ICA.

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ACKNOWLEDGMENT

The authors thank Christa Wellman for her help with the medical illustrations.

DISCLAIMER

Dr Ali Alaraj and Dr Victor Aletich are consultants for eV3 and Cordis-Codman. Dr Victor Aletich received a research grant from Micrus.

FIGURE LEGEND:**Figure 1:**

A. Axial CT angiography scans of the neck showing a large glomus tumor surrounding the left internal carotid artery.

B. Left common Carotid Artery angiogram showing the left external carotid artery feeders supplying the tumor (tumor blush), with displacement of the internal and external carotid artery anteriorly.

C. Left vertebral artery angiogram showing multiple muscular feeders from the cervical vertebral artery. The tumor appears to be encasing the upper cervical left vertebral artery at the level of C2.

D. Left common carotid artery angiogram showing the patent covered stent extending from the upper cervical left internal carotid artery down to the left common carotid artery, with immediate exclusion of the left external carotid artery and devascularization of the rest of the external carotid artery feeders to tumor.

E. Intra-operative image during the surgical resection of the tumor. The tumor was dissected free from the internal carotid artery (I). A vessel loop is applied around the common carotid artery (C) below the lower edge of the covered stent. Branches of the external carotid artery are ligated in order to avoid bleeding from retrograde flow. The Internal jugular vein (J) is ligated proximally (not shown) and the vagus nerve (V) involved in the tumor mass is ligated, transected and reflected laterally. The skin incision is extending superiorly and laterally in order to perform the mastoidectomy (M).

F. Post operative quantitative MRA confirming patency of the left internal carotid artery with blood flow volume in the Left ICA of 277 cc/minute.

