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Case report

Resorbable purified porcine skin gelatin cross-linked with glutaraldehyde spheres for preoperative embolization of carotid body paraganglioma

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Abstract. Chemodectomas are rare neuroendocrine tumors that typically arise at the carotid bifurcation and progressively englobe the internal and external carotid artery. Surgical asportation of the capsulated mass is the elective treatment. Pre-procedural embolization of this high vascular tumors is highly recommended because it has shown to improve surgical outcome by reducing both, mean blood loss and total operation time. Many different embolization techniques have been described in literature. In the here presented case we opted for an endovascular approach using resorbable purified porcine skin gelatin cross-linked with glutaraldehyde microspheres (Optisphere - MEDTRONIC) as an embolic agent. These turned out to be very safe and effective in improving surgical outcome by reducing operative blood loss and thus reducing treatment-related morbidity. (www.actabiomedica.it)

Key words: Paranganglioma, embolization, chemodectoma, interventional radiology, microspheres, high vascular tumor

Introduction

Carotid body chemodectomas, the most common type of paragangliogma in the head and neck region, are rare neuroendocrine tumors that arise from neuronal crest progenitors, most frequently situated at the carotid bifurcation.

The most common feeding arteries arise from the external carotid artery and are the ascending pharyngeal branch (64%), the superior thyroid branch (23%), occipital branch (21%), lingual branch (8%) and posterior auricular branch (5%) (1).

Chemodectomas are usually benign lesions, however in line with their natural evolution they are locally invasive and as they grow, they include both, the internal carotid artery (ICA) and the external carotid artery (ECA), leading eventually to life-threatening hemorrhages when infiltrating the arterial walls. The surgical removal of these tumoral masses is therefore indicated when detected, regardless of the stage, to prevent further adhesion and inglobation of the before said vessels.

The rarity of this tumor means that a common accepted therapeutic strategy is difficult to develop but there is a consensus (2) that in most cases pre-surgical embolization is required to improve the outcome and reduce morbidity and mortality linked to the surgery itself. Embolization is not only crucial in facilitating surgery, but it plays also an important role in palliative alleviation and thus increasing quality of life in patients with unresectable lesions with severe local symptoms, by decreasing vascularity and therefore dimensions of the tumor (3). Irradiation therapy is an alternative option when surgery cannot be performed.

Methods

Patient

It is about the case of a 64-years-old female patient with a unilateral left carotid body paraganglioma characteristically located at the carotid bifurcation between the ICA and ECA. The finding was by accident during imaging studies for other purposes. The patient was asymptomatic, without any evidence of cranial nerve disfunction, nor mass effect.

Diagnostic work-up began two years backwards including diagnostic CT studies and follow-up doppler ultrasound of the neck vessels. The dimension of the tumor remained stable over this period of time measuring about 10 x 15 mm. Pre-procedural contrast-enhanced TC imaging performed the same day of the embolization showed high vascularity and early enhancement (Figure 1.C; D), however it was not possible to determine with accuracy which was the tumor feeding vessel originating from the ECA. This was later assessed during the procedure itself with a digital subtraction angiography (DSA), resulting in being a very proximal branch of the superior thyroid artery (Figure 1.A). It was however possible to confirm the chemodectoma measurements and it was classified in Group II of the Modified Shamblin Classification proposed by Prasad SC et al (Table 1) (1) : the tumor was limited to the carotid bifurcation in the lower-middle compartment of the parapharyngeal space with an angle of contact over 90 but less than 180 degrees with the wall of the ICA and ECA. These parameters led to the assessment that intra-arterial stenting of the ICA was not necessary.

Embolization procedure

The procedure was performed with local anesthesia and sedation was avoided because patient cooperation is necessary for the neurological monitoring. A transfemoral approach was used to insert a 11 cm long 8 French introducer Super Sheath (BOSTON SCIENTIFIC) in the descending aorta. To achieve a more stable access a 95 cm long 7 French Vistabritetip Introducer Guide (CORDIS) was placed into the previous sheath and slowly advanced over the wire. The common carotid artery (CCA) was then accessed with a 5 French Vertebral Tempo Angiographic Catheter (CORDIS). After stable access to the distal aspect of the CCA, diagnostic digital subtraction arteriography (DSA) was performed with increased emphasis on defining the ECA to identify the dominant feeding vessels (Figure 1.A). This resulted to be a very proximal branch of the superior thyroid artery. After achieving selective catheterization of the main feeding vessel with a Progreat microcatheter (TERUMO), the controlled deployment of the embolic material was performed. We opted for 100 – 300 Micron resorbable Optisphere particles made from purified porcine skin gelatin cross-linked with glutaraldehyde (MEDTRONIC).

Figure 1 shows the digital subtraction angiogram before (Figure 1.A) and after (Figure 1.B) microsphere embolization which confirms a significant decrease in blood flow greater than 75% giving evidence that the procedure was successful.

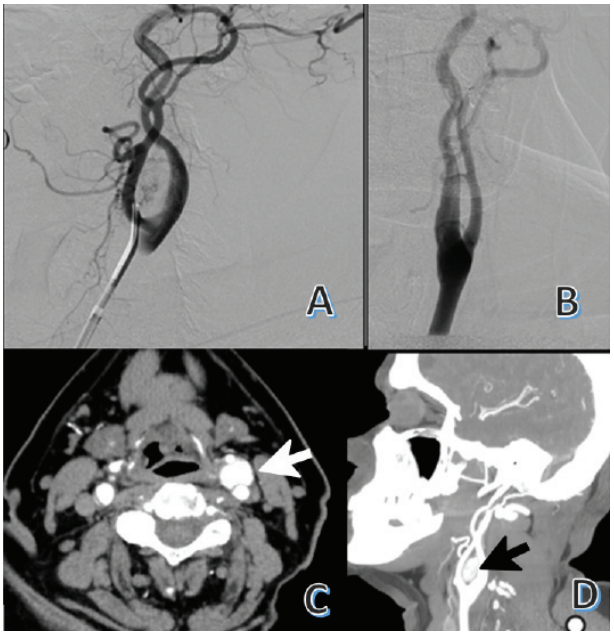
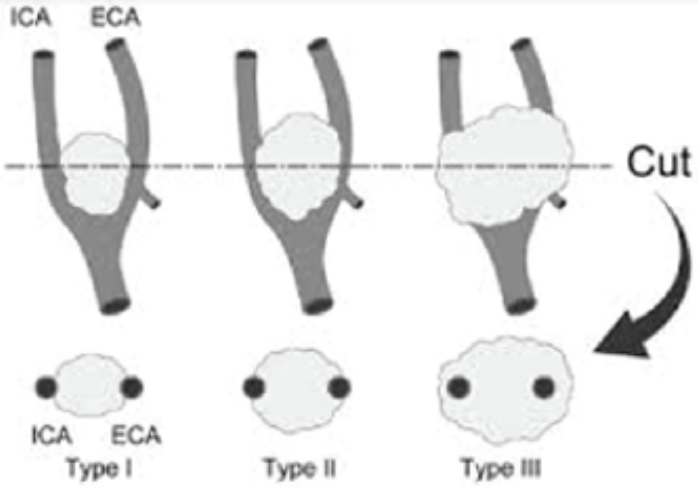


Figure 1. Pre- (A) and post- (B) embolization digital subtraction angiogram of the carotid body tumor that shows a significant decrease in vascularization greater than 75%. Preoperative contrast-CT of the neck shows a left mass (arrow) with intense contrast-enhanced vascularity that is located between the internal and external carotid arteries. Axial projection (C) with mass measurements and sagittal (D) MIP projection.

Table 1. Shamblin classification (A) and Modified Shamblin Classification proposed by Prasad SC et al (B). The Modified Shamblin Classification proposed by Prasad SC et al1 is an anatomical and radiological classification that describes tumor stage types based on the encirclement of the ICA and ECA that allows complete and systematic chemodectoma assessment done by the interventional radiologist and the vascular surgeon: for the choice of the right embolization technique; for the estimation of the possible intra-arterial stenting of the ICA; and for the adequate surgical preoperative planning.



Tumor type	Description	Image	Intra-arterial stenting	Approach
Class I	Tumor is limited to the carotid bifurcation (lower compartment of the parapharyngeal space) Tumors with an angle of contact of <90 degrees with the wall of the internal, external or the common carotid		Not indicated	Transcervical approach
Class II	Tumor is limited to the middle compartment of the parapharyngeal space Tumors with an angle of contact of >90 degrees but <180degrees with the wall of the internal, external or the common carotid		Not Indicated	Transcervical (a transparotid) approach
Class III	Tumors extending into the upper compartment of the parapharyngeal space +/- infratemporal fossa Tumors with an angle of contact of 180 degrees with the wall of the internal, external or the common carotid		Indicated	Transcervical-transmandibular approach
Class IV	Tumors extending into the upper compartment of the parapharyngeal space and infratemporal fossa and involving the jugular bulb Tumors with an angle of contact of >90 degrees with the wall of the internal, external or the common carotid		Indicated	Infratemporal Fossa Approach type A

At the end of the procedure a control eco-doppler showed decreased to absent blood flow in the tumor and preserved flow in the ICA and ECA.

Surgical Asportation and Histology

The day after embolization the patient underwent surgery and the tumor was completely and successfully resected (Figure 2.A; B).

Total operation time amounted to 90 min. Furthermore, the surgery was complication free and just minimal, not quantifiable, blood traces were lost.

The resected capsulated tumor was measured (15 x 18 mm) and cut in half to make a first evaluation of the embolic agent distribution by bare eye (Figure 2.C; D; E). It was then put in formalin an sent to the pathology lab for a detailed histological examination which showed the distribution of the spheres in the vessels (Figure 2.F; G).

Results

The elective treatment therapy for chemodectomas is the complete surgical resection. Being a high vascular tumor preoperative embolization is highly effective in facilitating surgery due to significant reduction in hypervascularity and thus control of bleeding that may be otherwise difficult during surgery[4]. The goal of successful embolization is a decrease in hypervascularity by >75%. Several techniques of carotid body tumor embolization have been reported in literature, ranging from an endovascular approach

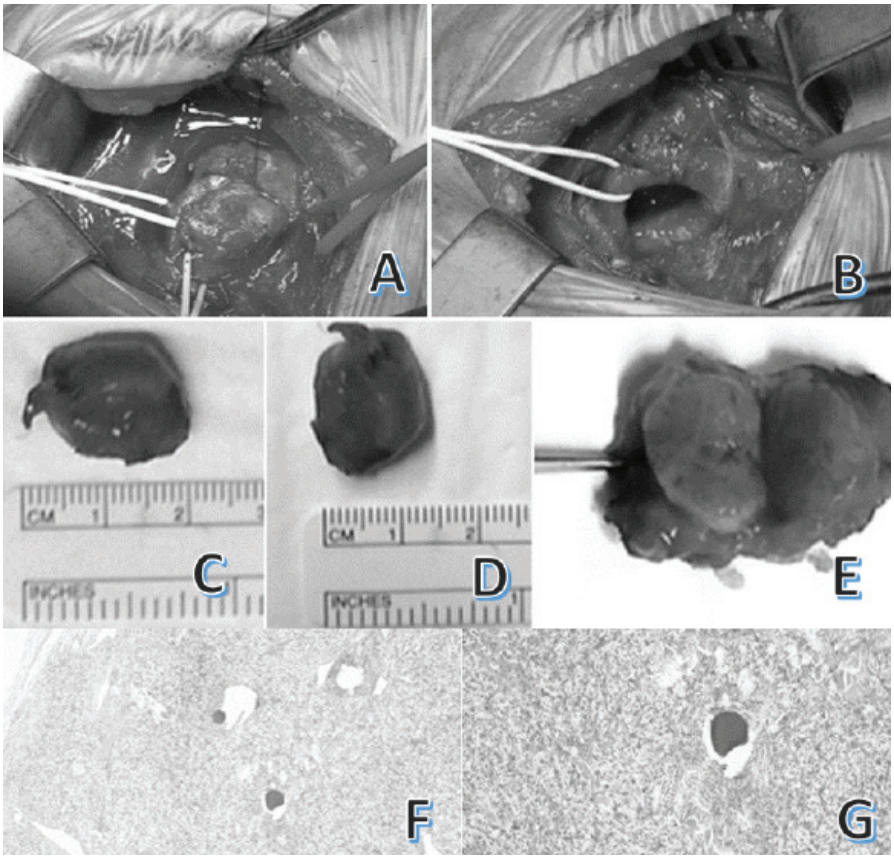


Figure 2. Intraoperative image of the chemodectoma (arrow) before surgical resection (A). Intraoperative image of the carotid bifurcation after resection of the chemodectoma (B). Excided carotid body tumor measurements in long (C) and short (D) axis. Dissected tumoral mass (E). Histopathological image of the carotid body tumor that shows the distribution of the embolic microspheres. (F) (G)

using different embolic agents as micro coils (5) or PVA (6) to a transcutaneous approach using ethanol (7) or Onyx (8) injection with simultaneous balloon occlusion.

In the here presented case we opted for an endovascular approach and the embolization was performed with microspheres Optisphere (MEDTRONIC). Optisphere is an embolic material made out of purified porcine skin gelatin that is crosslinked with glutaraldehyde for improving the mechanical strength of the spheres. The spherical shape provides smooth embolic delivery and even, predictable distribution. The spheres are offered in different size ranges and are designed for reliable, targeted embolization particularly indicated for hyper-vascular tumors as chemodectomas. The innovation of this kind of embolic material is that it completely resorbs after a period of time of approximately 12 weeks not leaving behind any kind of implants in the patient's body on the long term. In our case the hypervascular tumor containing the microspheres was resected the following day, however this is not always the case. Embolization of chemodectomas can also have the aim of tumoral mass size reduction in patients who cannot undergo surgery. Furthermore, an always present risk of embolization procedures includes non-target embolization. Both these conditions determine the permanence of foreign material in the patient's body. Therefore, having an alternative embolization material option that has comparable performance with the added benefit of controlled degradation over time seems reasonable.

The particularity of this case is that it was possible to study the microspheres distribution in the embolized tissue since the tumor was excised the following day and analyzed with compound optical microscopy. The microspheres were distributed homogeneously and occluded the target vessels resulting comparable to other non-resorbable microspheres.

Total operation time and blood loss during surgery were assessed with the intent to compare the results with literature findings to demonstrate the benefits of the pre-surgical embolization with these microspheres. We hereby referred especially to the multi-institutional survey of carotid body tumors from Ikeda et al. (9) that includes 150 patients in a time period of over 20 years. Our operating time amounted to 90 min, as expected, much shorter when compared to surgery time of patients of the same Shamblin II Class that didn't undergo pre-operative embolization where mean operation time was 262 min as evidenced in the above study.

Conclusions

The pre-surgical endovascular embolization of the here presented carotid body tumor using Optisphere (MEDTRONIC) microspheres as embolic agent has been shown to be very safe and effective in improving surgical outcome by reducing operative blood loss and thus reducing treatment-related morbidity.

Conflict of Interest: Prof. Gianpaolo Carrafiello is consulant for Medtronic. All other authors declare that he or she has no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article

Informed Consent: Informed consent was obtained from all individual participants included in the study.

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