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Case Report

Preoperative embolization of carotid body tumor by direct percutaneous intratumoral injection of N-butyl cyanoacrylate glue assisted with balloon protection technique

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Abstract

Substantial intraoperative bleeding during surgical removal of carotid body tumor may be a major problem in the management of these highly vascularized tumors. Traditional preoperative embolization via a transarterial access has proved effective but is often limited by complex vascular anatomy and small feeding vessels that is difficult to catheterize. We report two cases of carotid body tumor treated with direct puncture and intratumoral injection of N-butyl cyanoacrylate glue (NBCA) assisted with balloon protection technique for preoperative devascularization. The result was impressive and minimal bleeding loss during surgery was observed.

Keywords: Carotid body tumor; Direct puncture; Embolization; Glue; Paragangliomas

1. Introduction

Paragangliomas of the carotid bifurcation (carotid body tumors) are highly vascularized tumors.[1,2] Surgical removal is often associated with a significant intraoperative bleeding rate because of the vascular nature of the tumor. The value of preoperative embolization of hypervascularized tumors has been well established in the literature.[2–5] The traditional technique for preoperative devascularization performed by most interventional radiologists is superselective catheterization of the supplying branches and transarterial embolization with particulate agent. However, the possibility of this technique for treating paragangliomas are limited because of the presence of very small feeding branches from the internal carotid or external carotid arteries that cannot be directly catheterized.[1] We report our experience in two cases of carotid body tumor treated with direct puncture and intratumoral injection of glue assisted with balloon protection technique.

2. Case reports

2.1. Case 1

A 24-year-old male was hospitalized for a left neck pulsatile mass. Computed tomography (CT) showed a well-defined mass and associated mass effect of the tumor enlarging the carotid bifurcation. It exhibited intense contrast enhancement on dynamic scans. magnetic resonance (MR) imaging confirmed the location of this hypervascularized tumor in the carotid bifurcation, with intermediate signal intensity on T1-weighted (T1W) imaging and moderate high signal intensity on T2-weighted (T2W) imaging. Intense homogeneous enhancement occurred after intravenous administration of gadolinium. Preoperatively, a detailed angiography was performed. The study included selective series of the common carotid arteries, the internal and external arteries, and the vertebral arteries. This examination revealed a hypervascular mass with enlarged

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feeding vessels and attenuated staining (Fig. 1A). This mass was fed mainly by ascending pharyngeal arteries and small branches from the proximal trunk of the external carotid artery. Balloon occlusion test of the internal carotid artery (ICA) was performed to evaluate the compensation capacity of cerebral collateral circulation before surgical resection of the carotid body tumor. The anticoagulation protocol and neurological testing during the procedure was according to previous literature.[6] The patient passed the balloon occlusion test. Embolization was scheduled one day before the operation. However, because of the complex angioarchitecture with multiple, small feeding branches, involvement of branches arising from proximal external carotid artery and ascending pharyngeal artery that could not be directly catheterized, direct intratumoral embolization was a potentional option for treating this hypervascularized tumor.

The procedure was performed with general anesthesia to provide absolute immobility of the patient and to eliminate the pain of puncture or the glue injection. A 6-Fr Shuttle Sheath (Cook Incorporated, Bloomington, IN) was placed in the common carotid artery to perform control angiography before and after the injection of glue. The anticoagulation protocol consisted of an intravenous bolus of 3000 IU of heparin after a guiding catheter was placed in the common carotid artery. A nondetachable balloon (Magic B2, Balt, Montmorency, France) was positioned in the high cervical ICA and inflated during glue injection. The purpose of the inflated balloon in high cervical ICA was for flow arrest because continuous blood flow might promote glue retrograde migration into the intracranial circulation during glue injection *via* some feeding vessels that originated from proximal ICA or carotid bifurcation. The inflated balloon was not positioned at the carotid bifurcation because that might cause hypertensive crisis or other associated problems, including increased vagal tone (bradycardia, hypotention) during inflation of balloon. For puncture, a 19-gauge coaxial introducer puncture needle was used. After puncture, the needle was considered correct when blood reflux was slow but continuous. Parenchymography of the tumor was performed to verify arterial reflux, venous drainage, the absence of extravasation, and the vascular compartment of the tumor to be filled (Fig. 1B). Then the balloon was inflated during glue injection (Fig. 1C). Six punctures were done. About 15 mL low

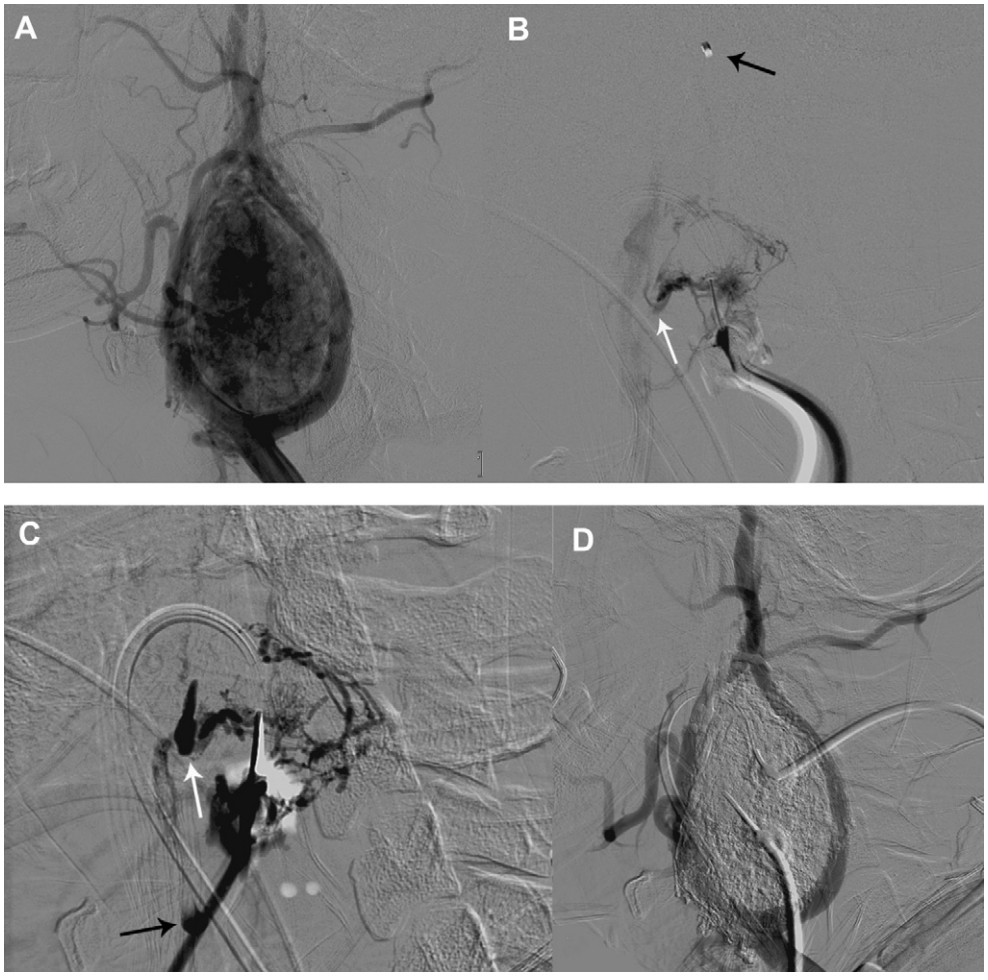

Fig. 1. (A) Left common carotid injection in the lateral view shows the hypervascular tumor with splaying carotid bifurcation. (B) Parenchymography in the lateral view demonstrates arteriovenous shunt (white arrow) with early opacified jugular vein and hypervascular stain. The inflated balloon is positioned at the high cervical internal carotid artery (black arrow). The contrast medium-filled balloon is subtracted. (C) Glue cast over the shunt (white arrow), and the tumor parenchyma is filled with glue. A glue particle in the jugular vein, but stopped migration after shunt had ceased (black arrow). (D) Left common carotid injection in the lateral view at the end of the procedure shows near total devascularization of the tumor. Note the patent internal carotid artery flow.

concentration of N-butyl cyanoacrylate glue (NBCA) (20−30%) was injected into the tumor and more than 90% of the tumor was finally devascularized (Fig. 1D). No reflux was observed. The procedure was stopped when the risk of arterial reflux to external carotid artery (ECA) or ascending pharyngeal artery (APA) was considered high. Bleeding from puncture sites was easily controlled by manual compression. Intraoperative blood loss was less than 100 mL, and pathology confirmed the diagnosis of carotid body paraganglioma.

2.2. Case 2

A 62-year-old woman presented with a swelling of the right side of the neck of two months' duration. The clinical examination was unremarkable except for the swelling. CT showed a well-defined mass and associated mass effect of the tumor enlarging the carotid bifurcation. The CT and MR imaging characteristics of the mass were the same as typical paragangliomas described in previous literature. Preoperatively, a detailed angiography revealed a hypervascular mass with enlarged feeding vessels and posterior displacement of the ICA (Fig. 2A). This mass was fed mainly by ascending pharyngeal arteries and small branches from the proximal trunk of external carotid artery. Balloon occlusion test of the ICA was performed and the patient passed the exam. Preoperative embolization was performed with general anesthesia. The anticoagulation protocol and direct puncture technique were the same as for case one. Glue was injected at two separate sites, and more than 95% of the tumor was finally devascularized (Fig. 2B). No unwanted glue migration was observed. Intraoperative blood loss was minimal, and pathology confirmed the diagnosis of carotid body paraganglioma.

3. Discussion

The value of preoperative embolization of hypervascularized tumors has been well established in the literature.[2−5] Several techniques can be used for this purpose: superselective catheterization of the supplying branches and transarterial embolization with particulate agents or a permanent liquid polymerizing agent, and direct intratumoral injection with a permanent liquid polymerizing agent.[5,7] In some cases, devascularization of hypervascularized tumors by covered stent placement in the external carotid artery have been reported.[8]

Paragangliomas are highly vascular, and surgical resection may be complicated by dramatic blood loss. By transarterial embolization of paragangliomas, complete devascularization of the tumor bed is often not achieved because of the complex angioarchitecture, characterized by multiple small feeding branches that cannot be directly catheterized, and possible vasospasm.[1] In an effort to overcome this well-recognized limitation, the technique of direct injection of cyanoacrylate from a percutaneous approach was initially described in 1990 by Deramond et al.[9] In 1994, Pierot et al.[5] and Casasco et al.[7] were the first to use direct puncture of hypervascular head and neck tumors, with excellent results. Abud et al.[1] reported their experience with direct percutaneous injection of cyanoacrylate for preoperative devascularization of head and neck paragangliomas. They achieved excellent results in nine patients, with angiography and clinically complete devascularization in five cervical tumors, including three carotid body tumors. No complications related to the embolization procedure were observed. One of the main advantages of intratumoral injection is easier access to the vascular tumor bed, which is not limited by arterial tortuosities, atherosclerotic disease, or induced vasospasm.

Although direct intratumoral injection of glue certainly results in more complete reduction of tumor vascularity, it has not been widely adopted. There may be several reasons for this, but a key issue is the unanswered question of whether the additional risks of this technique outweigh the benefits. Risks specific to the direct injection technique can be broken down into four components: distal embolization of glue, hemorrhagic risks from direct puncture, jugular vein migration of glue, and procedure risks of general anesthesia.

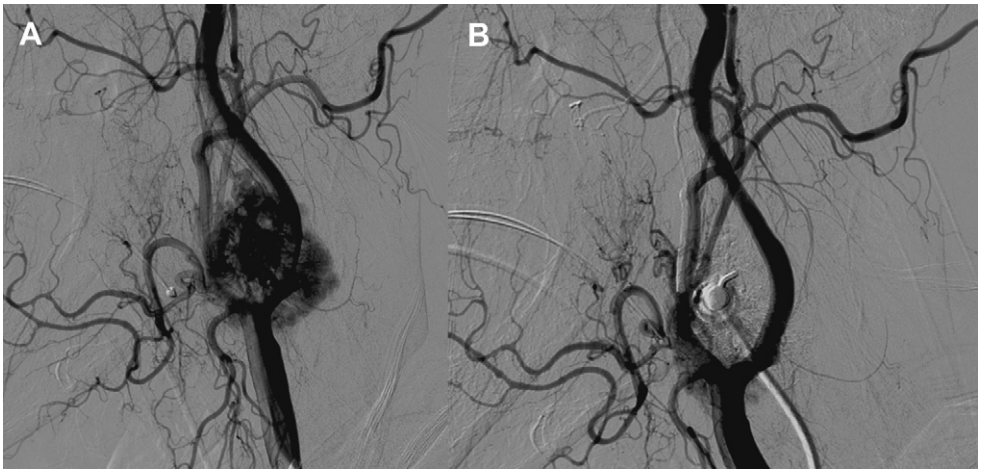

Fig. 2. (A) Lateral view of right internal carotid artery injection shows the hypervascular tumor with posterior displacement of internal carotid artery. (B) Right carotid injection in the lateral view at the end of the procedure shows near total devascularization of the tumor. A residual small area of tumor blush is seen overlapping the carotid bifurcation.

Casasco et al.[7] reported a large series of 65 hypervascular head and neck tumors, including 22 paragangliomas, treated with direct intratumoral injection of cyanoacrylate. They observed distal ischemic complications in two patients with juvenile angiofibromas and, therefore, suggested protecting the intracranial branches during the injection with nondetachable balloons. In their cases, the tumor locations were at the skull base, and numerous feeders arising from intracranial circulation and potential dangerous anastomosis between ECA/ICA and ECA/vertebral artery (VA) existed. Migration of glue into the intracranial circulation may occur through these ECA−ICA or ECA−VA communications. Although the ascending pharyngeal artery is considered to be the main feeder of carotid body tumors, and this type of tumor often derives its blood supply from multiple feeders of the ECA. Krishnamoorthy et al.[10] also reported a case with stroke from delayed embolization of polymerized glue following percutaneous direct injection of a carotid body tumor. The tumor was supplied by feeders from the ipsilateral ECA, ICA and VA. Although direct intratumoral injection of glue while protecting the intracranial branches with nondetachable balloons is a safe and effective method in this location, there should be concern when feeders from ICA or VA exist.

Hemorrhagic complications in the soft tissues of the neck were not observed here, also the previous studies[1], but could certainly occur. Preprocedure, careful inspection of the location of tumor, relationship between tumor and ICA, ECA from CT or MRI to avoid any unwanted puncture and to determine the puncture depth is important. In carotid body tumor, the puncture wound is easy to compress manually.

Jugular vein migration of glue could occur when intratumoral arteriovenous shunt exists or too low concentration of cyanoacrylate is used. Pulmonary complications from liquid cyanoacrylate embolization of brain arteriovenous malformation have been reported.[11] It could also occur while treating carotid body tumor because of hypervascular angioarchitecture of the mass. Parenchymography of the tumor to access arterial reflux, arteriovenous shunt, venous drainage is important. We adopted high concentration of glue (50%) to cease arteriovenous shunt and low concentration of glue (20%) to allow homogeneous intratumoral penetration of the embolic agent, a suggestion supported by Abud et al.[1]

Finally, the need for general anesthesia adds an invasive procedure to the care of these patients, in addition to the inherent risks of general anesthesia. For example, a balloon occlusion test or simply diagnostic angiography may be necessary before determining whether percutaneous injection under general anesthesia is necessary or feasible. In contrast, transarterial embolization can be performed at the time of the diagnostic angiography or following the balloon occlusion test. This is the limitation of this method.

In conclusion, direct puncture of head and neck paragangliomas with the intralesional injection of glue assisted with balloon protection technique has potential and should be considered for the management of selected patients. We think that, for carotid bifurcation glomus tumor, this method is safe, feasible, and effective, especially in combination with nondetachable balloons inflation in ICA during the injection of glue for preoperative tumoral devascularization. It is not limited by the number of arterial feeders, their origins, arterial tortuosities, atherosclerotic disease, or induced vasospasm.

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