Fibrin Sealant Injection: An Aid to Reduce Venous Bleeding during Jugular Bulb and Sigmoid Sinus Dissection in Glomus Jugulare (Jugulotympanic Paraganglioma) Surgery

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ABSTRACT

Glomus jugulare (jugulotympanic paraganglioma) surgery requires tumor dissection in the region of the jugular bulb, upper internal jugular vein, and sigmoid sinus. Despite ligation or external compression of the sigmoid sinus proximally and ligation of the internal jugular vein distally, troublesome venous bleeding can arise from the inferior petrosal sinus or condylar veins at the medial wall of the jugular bulb. Excessive packing in this area can place the integrity of the lower cranial nerves at risk. We report a technique in which Tisseel® fibrin sealant is injected into the ligated sigmoid sinus and internal jugular vein. This forms an internal cast around the tumor in the sigmoid-jugular complex and helps seal the inferior petrosal sinus and condylar veins. This allows for safer dissection with reduced venous bleeding. Our experience in five cases has shown this technique to be effective.

KEYWORDS: Glomus jugulare, jugular foramen, paraganglioma, Tisseel fibrin sealant, hemostasis

Jugular paragangliomas arise from the medial wall of the internal jugular vein. They are frequently located intraluminally within the sigmoid—jugular complex, so opening of this system is required.^{1–3} The sigmoid sinus is traditionally either ligated or

compressed with extraluminal packing.^{1,3} The internal jugular vein is traditionally ligated but, as jugular paragangliomas often shunt blood with high venous outflow, the internal jugular vein can often be left initially unligated to preserve venous drainage

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until the tumor is isolated and its arterial supply devascularized.⁴

Dissection of the ligated sigmoid sinus and internal jugular vein often encounters bleeding from the inferior petrosal sinus and condylar veins.^{1,5-7} The inferior petrosal sinus often consists of multiple channels and courses from the cavernous sinus, emptying into the medial aspect of the jugular bulb at the petrosal confluence.^{1,8,9} The inferior petrosal sinus is often associated with the anterior condylar vein.⁶ The posterior condylar vein (condylar emissary vein in the international anatomic nomenclature) often gives rise to the most significant bleeding. It generally takes its origin from the posteromedial aspect of the jugular bulb but can also rise from the medial side of the distal sigmoid sinus or the anterior condylar confluence.¹⁰⁻¹² The posterior condylar vein often drains into the suboccipital cavernous sinus (the venous plexus surrounding the horizontal portion of the vertebral artery) or the deep cervical vein.^{10,13-15}

Bleeding from the inferior petrosal sinus and condylar vein can hamper accurate dissection and often requires absorbable hemostatic oxidized cellulose polymer mesh to be packed into the vessel openings, thereby preventing further bleeding.^{1,3} Another technique involves injection of a Gelfoam-thrombin paste into the jugular bulb to compress the inferior petrosal sinus followed by further packing with muscle.⁷ Overpacking of the inferior petrosal sinus can cause cranial nerve injury as this sinus passes between cranial nerves IX, X, and XI.^{1,6} Preoperative embolization of the inferior petrosal sinus and posterior condylar vein has also been described, with resulting decreased surgical time, reduced risk of cranial nerve damage, and reduced blood loss.⁶ Cranial nerve preservation is the main factor in reducing postoperative morbidity and is also dependent on tumor size.⁵

Tisseel® sealant (Baxter Healthcare Ltd., Thetford, UK) is fibrin glue that can be injected from premixed, prefilled syringes. Fibrin glue injected into the cavernous sinus has been reported to control venous oozing with no significant clinical side effects in 217 neurosurgical procedures.¹⁶ In these cases blood flow was reestablished within 2 to 3 months.¹⁶ Another report details the use of fibrin glue to control venous bleeding after injection into the epidural space ($n = 200$), anterior cavernous sinus ($n = 46$), vertebral venous plexus ($n = 20$), and superior petrosal sinus ($n = 20$).¹⁷ In this series good results were observed in all but two patients in whom the superior petrosal sinus was injected with fibrin glue.¹⁷ These two patients experienced complications caused by occlusion of the veins draining the brain stem.¹⁷

We describe a technique used as an adjunct to ligation of the internal jugular vein and sigmoid sinus during the mastoid and neck approach to small glomus jugulare tumors (without involvement of the internal carotid artery, neck, or posterior cranial fossa).

TECHNIQUE

Following preoperative embolization, a mastoid neck approach is performed. During the dissection of the upper neck, the internal jugular vein is identified and dissected free, with a vascular loop placed around it. Later in the procedure it is ligated with two "0" silk ligatures. Following a wide mastoidectomy, the sigmoid sinus, jugular bulb, and posterior fossa dura either side of the sigmoid sinus is widely exposed. The tumor in the jugular bulb and hypotympanum is then widely exposed usually preserving the facial nerve in its bony bridge. At this stage the dura of the posterior fossa is incised either side of the sigmoid sinus. An aneurysm needle is passed through these incisions to allow a double "0" silk ligature to be passed and tied around the sigmoid sinus.

Tisseel fibrin sealant is prepared in a premixed, prefilled syringe according to the manufacturer's guidelines. A small incision is made into the sigmoid sinus just below the ligatures. The needle of the syringe is inserted into the sigmoid sinus. A further silk ligature passed around the sinus containing the needle is tied with one throw (inferior to the opening in the sinus) and held with artery forceps. This subsequently helps prevent leakage and allows instillation of the fibrin sealant under some pressure.

A small venotomy is made into the internal jugular vein just above the tied ligature inferiorly. A further ligature is placed but not tied above this venotomy. Fibrin sealant is then injected until it is seen to emerge from the venotomy in the internal jugular vein. The needle is removed from the sigmoid sinus. The ligatures in the sigmoid and internal jugular vein are then tied tightly to seal the fibrin sealant within the jugulosigmoid complex. In cases where the jugulosigmoid complex is obstructed by tumor and no sealant emerges at the venotomy inferiorly, a further fibrin injection can be made into the jugular venotomy in a retrograde direction. Further fibrin injections can also be made as dissection advances.

Following this maneuver, the bridge of bone (usually containing tumor) between the jugular bulb and the upper internal jugular vein is widely removed. Tumor around the jugular bulb and hypotympanum can be debulked. As the dissection approaches the level of the medial wall of the jugular bulb the sigmoid sinus can be opened. Here the fibrin sealant forms a cast within the vein (Fig. 1). This cast together with the lateral wall of the sigmoid and bulb can be progressively dissected away from tumor within the lumen of the sigmoid or bulb. In comparison to other techniques there is significantly less bleeding from the inferior petrosal sinus and condylar veins as these have been sealed off by the fibrin (Fig. 1). The internal jugular vein is dissected free of an overlying accessory nerve and surrounding tissues up to the jugular foramen where it is excised. When the vein is full of sealant it becomes rigid and easier to manipulate.

Figure 1 (A) The sigmoid sinus has been opened: The fibrin sealant cast is visible inside (white arrow). The facial nerve is located within the bony buttress (F). The ligatures around the sigmoid are indicated (black arrows). (B) The fibrin sealant has formed a cast (arrow) of the sigmoid sinus which is being dissected away from the medial wall of the sinus. (C) Following removal of the fibrin cast and lateral wall of the sigmoid and bulb, tumor is seen filling the lumen of the jugular bulb (arrow). (D) Further dissection of tumor away from the medial wall of the jugular bulb reveals a venous tributary orifice in the medial wall of the bulb (arrow) with minimal bleeding.

This technique has been successfully used in five cases. Only one of these five cases developed new lower cranial nerve weakness postoperatively (vagal and glossopharyngeal nerves) and this was felt to be secondary to dissection of the disease, not the use of fibrin sealant. There were no other complications and no thromboembolic events during the use of this technique.

DISCUSSION

Different techniques have been used during the dissection of the sigmoid sinus, jugular bulb, and internal jugular vein for paraganglioma resection. These include packing the inferior petrosal sinus and condylar veins with a cellulose polymer hemostatic mesh or with pieces of muscle after injection of Gelfoam and thrombin paste.^{1,3,6,7} However, overpacking of the inferior petrosal sinus with hemostatic mesh can cause cranial nerve injury as this sinus often passes between cranial nerves IX, X, and XI.^{1,6}

The fibrin sealant technique is advantageous in that it prevents bleeding from the inferior petrosal sinus and posterior condylar vein by sealing their openings before dissection. It also helps provide a rigid internal jugular vein which can be easily manipulated and dissected away from tissues inferior to the jugular foramen.

Clearly, there is a theoretical risk of instillation into the pulmonary arterial or cerebral venous circulations with resultant pulmonary embolism or cerebral venous infarction. It is therefore essential that the internal jugular vein and sigmoid sinus are adequately ligated before sealant injection.

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