Surgical Neurology International

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Technical Note

Combined use of covered stent and flow diversion to seal iatrogenic carotid injury with vessel preservation during transsphenoidal endoscopic resection of clival tumor

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Received: 07 March 14 Accepted: 21 April 14 Published: 31 May 14

This article may be cited as:
Shakir HJ, Garson AD, Sorkin GC, Mokin M, Eller JL, Dumont TM, *et al*. Combined use of covered stent and flow diversion to seal iatrogenic carotid injury with vessel preservation during transsphenoidal endoscopic resection of clival tumor. Surg Neurol Int 2014;5:81.

Available FREE in open access from: http://www.surgicalneurologyint.com/text.asp?2014/5/1/81/133638

Abstract

Background: Transsphenoidal tumor resection can lead to internal carotid artery (ICA) injury. Vascular disruption is often treated with emergent vessel deconstruction, incurring complications in a subset of patients with poor collateral circulation and resulting in minor and major ischemic strokes.

Methods: We attempted a novel approach combining a covered stent graft (Jostent) and two flow diverter stents [Pipeline embolization devices (PEDs)] to treat active extravasation from a disrupted right ICA that was the result of a transsphenoidal surgery complication. This disruption occurred during clival tumor surgery and required immediate sphenoidal sinus packing. Emergent angiography revealed continued petrous carotid artery extravasation, warranting emergent vessel repair or deconstruction for treatment. To preserve the vessel, we utilized a covered Jostent. Due to tortuosity and lack of optimal wall apposition, there was reduced, yet persistent extravasation from an endoleak after Jostent deployment that failed to resolve despite multiple angioplasties. Therefore, we used PEDs to divert the flow.

Results: Flow diversion relieved the extravasation. The patient remained neurologically intact post-procedure.

Conclusions: This case demonstrates successful combined use of a covered stent and flow diverters to treat acute vascular injury resulting from transsphenoidal surgery. However, concerns remain, including the requirement of dual antiplatelet agents increasing postoperative bleeding risks, stent-related thromboembolic events, and delayed in-stent restenosis rates.

Key Words: Carotid artery stenting, clival tumor, Jostent, Pipeline embolization device, transsphenoidal resection

Access this article online

Website: www.surgicalneurologyint.com

DOI: 10.4103/2152-7806.133638

Quick Response Code:

INTRODUCTION

Carotid injury is a complication of transsphenoidal approaches to the sella and clivus. The narrow operative field required for this approach limits effective intraoperative management of vascular injury.[1,6] Intracranial tumors complicate the anatomy by eroding through local structures, including the carotid artery, creating potential for iatrogenic injury. Traditionally, internal carotid artery (ICA) injury during surgery is treated by artery ligation; however, this method can lead to numerous complications.[3,5] Endovascular techniques are often required in these circumstances. We report a case of petrous ICA injury during transsphenoidal endoscopic-assisted resection of a clival chordoma. Emergent angiography revealed active extravasation from the petrous segment of the carotid artery. In light of the imminent nature of the injury because the patient was acutely hemorrhaging and the lack of ability to definitively perform a physiologic balloon test occlusion, we primarily attempted to repair, rather than endovascularly sacrifice, the carotid artery. Carotid artery preservation was enabled by stenting using off-label devices, including a covered stent graft (Jostent; Jomed International, Helsingborg, Sweden) and flow-diverting devices [Pipeline embolization device (PED); Covidien, Irvine, CA, USA].

TECHNICAL NOTE

Background

A 61-year-old woman initially presented with a clival tumor. During transsphenoidal resection of the tumor, ICA injury was identified, prompting emergent diagnostic angiography after sinus packing and administration of vasoconstrictors failed to control the bleeding. Angiography revealed active extravasation from the petrous carotid artery, despite sinus packing [Figures 1 and 2].

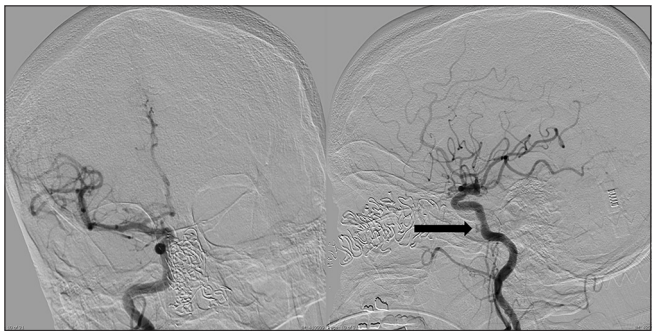

Figure 1: Digital subtraction angiogram. Anteroposterior (left) and lateral (right) projections of right common carotid artery injection. An area of extravasation is appreciated in the anterior and medial cavernous segment (arrow). The extravasation is not visualized on the AP view due to artifact caused by nasal packing

Treatment

A 6-French long sheath Neuron Max catheter (Penumbra, Alameda, CA, USA) was transfemorally placed in the distal cervical ICA. After administering a loading dose of prasugrel (60 mg) and aspirin (650 mg), the disrupted carotid artery segment was crossed using an SL-10 microcatheter (Boston Scientific, Natick, MA, USA) and a 0.0014-inch Synchro-2 microwire (Boston Scientific). While the Synchro-2 microwire was exchanged for a 0.0014-inch balance middleweight microwire (Abbott Vascular, Abbott Park, IL, USA) and the SL-10 microcatheter removed, a 4 × 12 mm Jostent was brought into position and deployed [Figure 3]. Post-deployment, there was reduction in extravasation; however, an endoleak around the stent persisted due to failure of the Jostent to appose the vessel wall around the proximal curve of the petrous carotid [Figure 4]. Attempts at delivering another Jostent and a balloon-mounted stent to seal the endoleak failed due to difficulty of entering the Jostent around the curve between the horizontal and vertical petrous segments. Additional angioplasties with non-compliant Sprinter balloons (Boston Scientific) also failed to address the endoleak. Instead, a 4.5 × 18 mm PED was delivered using a Marksman microcatheter (Covidien) and resulted in diversion of flow and reduction of the endoleak. A second PED was then placed over the first device with immediate resolution of all endoleak and extravasation. The patient was returned to the intensive care unit and left intubated with nasal and sphenoidal packing in place. Twelve hours later, a repeat angiogram revealed resolution of extravasation and excellent flow through the stents [Figure 5]. The packing was left in place for an additional 48 h, after which the patient was brought to a hybrid operating room–interventional suite where a diagnostic catheter was placed in the left ICA and angiography performed to confirm lack of extravasation. Endoscopic-assisted removal of nasal and

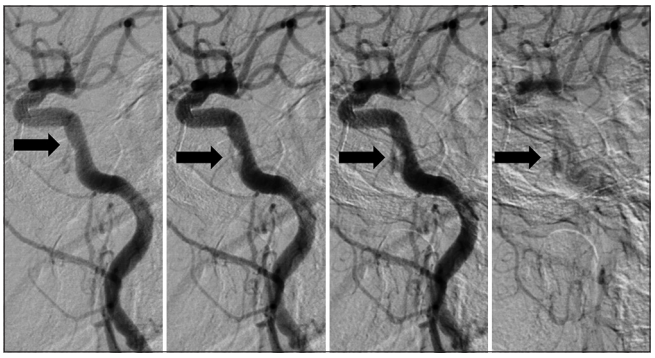

Figure 2: Digital subtraction angiogram. Magnified views of lateral projections of right common carotid artery injection. An area of extravasation is appreciated in the anterior cavernous segment (arrows). The four images are from early (left) to late (right) arterial phase of the injection, displaying the time course of the extravasation

Figure 3: Digital subtraction angiogram. (Left) Lateral projection of right internal carotid artery injection.The non-deployed Jostent has been positioned at the site of the extravasation (arrow). (Right) X-ray from same lateral view performed with inflation of the Jostent delivery balloon (arrow)

Figure 4: Digital subtraction angiogram after Jostent deployment but before Pipeline embolization device placement. Lateral projection of right internal carotid artery injection displays slowed but persistent contrast extravasation.An endoleak is evident at the proximal margin of the stent (arrow)

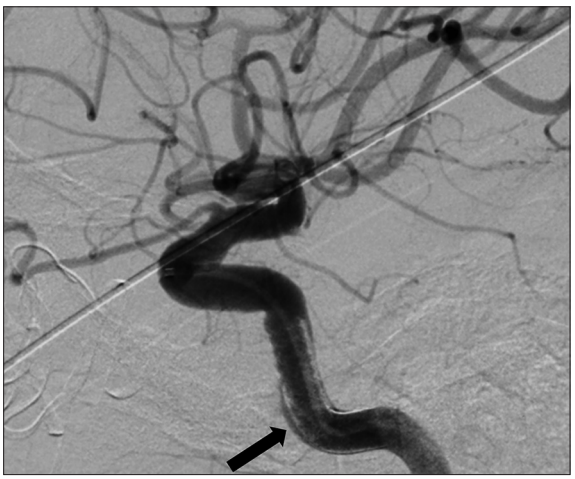

Figure 5: Digital subtraction angiogram 12 hours after the initial carotid injury. Lateral projection of right internal carotid artery injection displays resolution of contrast extravasation. Contrast stasis within the area of endoleak is present (arrow)

sphenoidal packing was then performed, and hemostasis was confirmed both endoscopically and through angiography. Following this, the patient was extubated and subsequently discharged, without any neurological deficits. She was placed on prasugrel for a course of 12 months and aspirin for life. The pathology report was consistent with chordoma, and proton beam therapy is planned for residual disease.

Follow-up evaluation

At the 1-month follow-up evaluation, the patient remained neurologically intact and reported no interval neurologic sequelae. A computed tomographic angiogram obtained at that time revealed wide stent patency, with no flow restriction.

DISCUSSION

Stenting via the Jostent has been reported for anecdotal cases of intracranial aneurysm and traumatic carotid cavernous fistula.[3] Kocer *et al*.[5] reported the case of a 58-year-old woman who underwent transsphenoidal resection of a pituitary adenoma. The case was complicated by injury to the ICA; angiography revealed contrast material extravasation in the sphenoid sinus from a laceration in the cavernous section of the ICA and a high-flow carotid cavernous fistula with retrograde cortical venous drainage. Because the collateral circulation was not sufficient for balloon occlusion, the injury was treated with Jostent placement. The 3-month follow-up angiogram showed absent filling of the carotid cavernous fistula and normal ICA patency. Similarly, the PED has been effective in flow-diversion treatment of giant skull base aneurysms.[4,8] Kan *et al*.[4] noted a 68% rate of aneurysm occlusion 3 months post-PED procedure. Additionally, in the Pipeline for Uncoilable or Failed Aneurysms (PUFS) trial, 81.8% of PED-treated aneurysms showed complete occlusion at 180 days.[2] However, to our knowledge, there has been no report of combined application of the two types of stents (covered and flow-diverter) for coverage of disrupted carotid arteries for salvage and preservation with resolution of persistent endoleak. The uniqueness of this case stems from using a Jostent and PEDs to treat a hemorrhage from the right ICA as a complication of transsphenoidal surgery, as opposed to cases involving preexisting aneurysms.[2,4-6,8] Covered stent grafts have been used for endovascular repair of vascular injury.[7] However, the tortuous intracranial circulation poses challenges for repair of these injuries with covered grafts. In this case, the Jostent, delivered across the injured segment, did not fully appose the vessel wall around an adjacent curve (despite multiple angioplasties), resulting in reduced but continued extravasation. With the addition of PEDs, flow was diverted away from the space between

the stent and carotid wall (endoleak site) halting extravasation (despite the fact that a flow diverter is not a fully covered stent), resulting in thrombosis at the rupture site and resolution of extravasation. A covered Jostent stent graft was used first, because although the Pipeline was considered for a primary attempt at repair, the fact that flow diversion does not seal a hole but rather diverts flow was troublesome, given the actual disruption of the artery. Although resolution of the extravasation demonstrates successful combined use of these devices to treat a vascular injury resulting from transsphenoidal surgery, concerns remain, including the requirement of dual antiplatelet agents increasing postoperative bleeding risks, stent-related thromboembolic events, and delayed in-stent restenosis rates.

DISCLOSURE

Dr. Dumont, Dr. Eller, Mr. Garson, Dr. Leonardo, Dr. Popat, Dr. Shakir, and Dr. Sorkin report no financial relationships. Dr. Mokin has received an educational grant from Toshiba. Dr. Siddiqui has received research grants from the National Institutes of Health (co-investigator: NINDS 1R01NS064592-01A1, Hemodynamic induction of pathologic remodeling leading to intracranial aneurysms and co-investigator NINDS 5 Ro1 EB002873-07, Micro-Radiographic Image for Neurovascular Interventions), and the University at Buffalo (Research Development Award); holds financial interests in Hotspur, Intratech Medical, StimSox, Valor Medical, Blockade Medical, and Lazarus Effect; serves as a consultant to Blockade Medical, Codman & Shurtleff, Inc., Concentric Medical, ev3/Covidien Vascular Therapies, GuidePoint Global Consulting, Lazarus Effect, MicroVention, Penumbra, Inc., Stryker Neurovascular and Pulsar Vascular; belongs to the speakers' bureaus of Codman & Shurtleff, Inc. and Genentech; serves on National Steering Committees for the following company-sponsored trials: 3D Separator (Penumbra, Inc.), FRED (MicroVention) and SWIFT PRIME (Covidien); serves on advisory boards for Codman & Shurtleff and Covidien Neurovascular; and has received honoraria from Abbott Vascular and Codman & Shurtleff, Inc. for training other neurointerventionists in carotid stenting and for training physicians in endovascular stenting for aneurysms. Dr. Siddiqui receives no consulting salary arrangements. All consulting is per project and/or per hour.

ACKNOWLEDGMENT

The authors thank Paul H. Dressel BFA for preparation of the illustrations and Debra J Zimmer for editorial assistance.

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