Preoperative Protective Endovascular Covered Stent Placement Followed by Surgery for Management of the Cervical Common and Internal Carotid Arteries with Tumor Encasement

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Abstract

Objective The objective of this study was to report the outcomes on a preliminary cohort of patients with tumor encasement of either, or both, the cervical internal carotid artery (ICA) and common carotid artery (CCA) following preoperative covered stent placement and surgical resection.

Setting This study was set at the University of Florida College of Medicine, Jacksonville, FL.

Participants Subjects who received preoperative stenting of the cervical ICA/CCA before surgical resection of head and neck tumors between April 1, 2015, and July 31, 2015 were participated.

Main Outcome Measures The outcomes assessed were resectability of tumors after stenting, histopathological assessment of specimen margins, complications associated with stenting.

Results Five subjects received preoperative covered stent placement of the ICA/CCA before surgical resection. The mean age was 65.2 years. Median follow-up was 3.5 months. Excision of the adventitia from the stent was performed in all subjects. No intraoperative complications occurred. One vascular-related complication occurred in one subject who suffered occlusion of the stent, sustaining a ministroke. No involvement of tumor at the deep margin (inner surface of adventitia) of the resection was seen in any subjects.

Keywords

- internal carotid artery
- common carotid artery
- squamous cell carcinoma
- head and neck neoplasms

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Conclusions Preoperative covered stent placement of the cervical ICA/CCA in the management of subjects with head and neck tumors who display encasement on preoperative imaging may represent a safe and effective treatment.

Introduction

Encasement of the common carotid artery (CCA) and/or internal carotid artery (ICA) in patients with tumors of the head and neck presents a substantial dilemma in surgical management. Encasement of the CCA/ICA of greater than 270 degrees renders the tumor “unresectable.” Attempts at resection lead to a substantial increase in mortality and morbidity. Although the 5-year survival for patients with CCA/ICA encasement is less than 5 to 13%,^{1,2} the benefit of CCA/ICA resection on survival was demonstrated by Loré and Boulos as well as Nishinari et al.³ Attempts at resection of the CCA/ICA with tumor encasement are associated with significant morbidity and complications such as carotid rupture, stroke, and associated cerebral damage. Though vein and arterial grafting following carotid removal is an option in these patients, this treatment in itself has a high rate of morbidity.⁴

Partial removal of tumor is an option; however, this predisposes the patient to a high likelihood of recurrence.^{5,6} Endovascular techniques have augmented the management of these tumors of the ICA at the intracranial level.⁷ Recently, there have been multiple reports which have shown the utility in preoperative stenting when managing patients with paragangliomas of the ICA, complex tympanojugular paragangliomas, and bilateral carotid body tumors.⁸ Results have shown successful removal of tumors with a low rate of morbidity. The formation of a neointimal lining on the luminal surface of the stent allows for excision of the tumor and associated adventitia from the stent.⁹ Though excellent results have been shown in subjects with a variety of intracranial tumors, no studies have yet to assess the feasibility of this technique in patients with encasement of the cervical ICA by squamous cell carcinoma of the neck.

The aim of this study is to report the outcomes of our preliminary cohort of patients with tumor encasement of the cervical ICA/CCA who underwent preoperative covered stent placement before cervical malignant tumor resection.

Methods

The investigators designed a retrospective study and enrolled a sample of subjects who received preoperative covered stent placement of the cervical ICA/CCA before surgical resection of head and neck tumors between April 1, 2015, and July 31, 2015. Subjects were included if they (1) had tumor encasement of the cervical ICA; (2) underwent preoperative covered stent placement of the cervical ICA; and (3) had undergone surgical resection. The outcomes assessed were resectability of tumors after stent placement, histopathological assessment of specimen margins, and complications associated with stenting.

Protocol

A standard protocol was followed for all patients (►Fig. 1). All subjects received a preoperative contrast-enhanced computed tomography (CT) of the neck as part of their preoperative evaluation for head and neck tumors (►Fig. 2). When no carotid encasement was involved, the patient was managed with protocol consistent per National Comprehensive Cancer Network guidelines.¹⁰ When carotid encasement of greater than 270 degrees was present, the subject was referred to interventional radiology. Angiography of the CCA/ICA was performed (►Fig. 3). The purpose of the study was to assess stenting regardless if the patient could tolerate temporary balloon occlusion; therefore, temporary balloon occlusion was not performed in subjects as they were going to receive stenting regardless of the outcome of temporary balloon occlusion. A standard approach was taken where the common femoral artery was accessed and a vascular sheath placed over a Bentson wire (Cook Inc, Bloomington, IN). The size of the vascular sheath was determined on a case-by-case basis depending on the size of the covered stent to be placed. A Simmons 2 catheter (Terumo Medical Corporation, Somerset, NJ) was then advanced into the thoracic aortic arch. Angiography of the ICA/CCA was then performed and assessed for patency. The external carotid artery and its branches were also assessed. If patent, embolization of the external carotid artery was performed utilizing an Amplatzer IV plug (St. Jude Medical, Inc., St. Paul, MN). Next, a heparin-bonded Viabahn covered stent (W. L. Gore and Associates, Inc., Flagstaff, AZ) was advanced on its deployment system over a Rosen wire to the location of the ICA and/or CCA depending on

Fig. 1 Protocol for patients with tumor encasement of the CCA and ICA. CT, computed tomography; CCA, common carotid artery; ICA, internal carotid artery.

Fig. 2 A contrast-enhanced CT of the neck from a patient with T4N3cM0 transglottic squamous cell carcinoma. (A) Complete obliteration of the supraglottic airway with extension into the paratracheal and postcricoid spaces, and almost complete demineralization and invasion of the cricoid cartilage with displacement of the right CCA posteriorly. (B) Almost complete obliteration of the oropharynx with greater than 270 degrees of encasement of the right ICA and CCA, as well as multiple centrally enhanced necrotic cervical lymph nodes with extracapsular spread to the right sternocleidomastoid muscle. CT, computed tomography; CCA, common carotid artery; ICA, internal carotid artery.

tumor involvement (► **Fig. 4**). Covered stent placement included at least 1 cm proximal and distal to the area of tumor involvement as determined on the CT of the neck. Should more than one stent be needed to treat the affected area, the stents were placed with at least 1 cm of overlap. Each patient was administered clopidogrel, 75 mg, daily, and acetylsalicylic acid, 325 mg, daily as soon as it was decided to place an endovascular covered stent. This was continued for 6 months. With all subjects in the study, there was an urgency to perform resection as soon as possible given the progression of their malignancy; therefore, subjects were often started on anticoagulation on the day of stent placement.

Approximately 1 to 22 days following stenting, excision of the tumor was performed with neck dissection if indicated. Some

patients in the study needed to undergo immediate resection within several days following stent placement. This was due to the aggressive nature of their malignancy. Transmandibular with a preplated osteotomies were performed when necessary. Proximal control of the common carotid was obtained before approaching the tumor. Resection of the tumor was obtained with deep margins being taken down to the mesh interstices of the stent. The deep margins were removed en bloc with the rest of the tumor.

Results

The sample was composed of five subjects who received preoperative covered stent placement of the ICA/CCA before

Fig. 3 An angiogram of the right carotid system. (A) Lateral and (B) anterior–posterior views depicting no significant atheromatous changes or stenosis of the right CCA, ICA, or proximal external carotid artery with soft tissue blush arising from the superior thyroidal, lingual, and facial branches of the proximal external carotid artery indicating tumor opacification. CCA, common carotid artery; ICA, internal carotid artery.

Fig. 4 (A) Lateral and (B) anterior–posterior views of an angiogram of the right carotid system depicting selective coil embolization of the tight lingual and facial arteries, successful use of overlapping stents of the distal right CCA, carotid bulb, and right cervical ICA, with preserved intracranial vasculature. The patient underwent pharyngolaryngectomy, bilateral modified radical neck dissection, and anterolateral free flap harvest for reconstruction. CCA, common carotid artery; ICA, internal carotid artery.

surgical resection. All subjects exhibited encasement of greater than 270 degrees of the ICA/CCA on preoperative imaging. Descriptive statistics of the study population are displayed in ► **Table 1**. The mean age was 65.2 years, and three of five subjects received preoperative chemotherapy and radiation. The type of tumor in all subjects was squamous cell carcinoma. Primary tumor sites include the larynx/pharynx ($n = 2$), pharynx ($n = 1$), and tonsil ($n = 1$). One subject's primary was unknown; however, they failed radiation therapy. Three of five subjects failed radiation and chemotherapy before stenting and resection. Median follow-up was 3.5 months. Excision of the adventitia from the stent was performed in all subjects during tumor resection (► **Fig. 5**). No intraoperative complications occurred. One vascular-related complication occurred in one subject who had decreased vision on the right eye and mild syncopal episodes. He was found to have complete occlusion of the stented segment of the right ICA on follow-up imaging. The patient's syncopal episode resolved, and his visual deficit improved with fludrocortisone. He went on to develop distal reconstitution at the skull base. Recanalization was not performed due to risk of distal embolization of thrombus and subsequent potential for major stroke. The subject's anticoagulation regimen included clopidogrel, 75 mg, daily, and acetylsalicylic acid, 325 mg, for 6 months.

No involvement of tumor at the deep margin (inner surface of adventitia) of the resection was seen in any of the subjects (► **Fig. 6**). No spontaneous hemorrhage or pseudoaneurysm was witnessed.

Discussion

This case series suggests that preoperative covered stent placement of the CCA/ICA when tumor encroachment is present allows safe oncologic resection, with minimal morbidity. The technique described within is similar to that

reported by Nussbaum et al. They described performing an “extarterectomy” followed by suturing in a synthetic patch circumferentially around the ICA following stenting and resection; however, we did not feel that was advantageous in our study cohort.¹¹ Lopes and Wakhloo assessed the concept of creating a new “neointimal lining” by deploying self-expanding stents in swine carotid arteries.⁹ At 3 and 6 weeks after surgery, they removed the carotid wall successfully leaving the neointima and stent to support blood flow.

Yu et al attempted to classify the involvement of tumor with the ICA/CCA and internal jugular vein by level of encroachment.¹² Using CT evaluation, they classified tumors as: type I, compression and deformation of CCA or ICA; type II, obliteration of IJV on segmental axial CT views; type III, displacement of CCA or ICA; type IV, tumor encasement of greater than 180 degrees of the circumference of the carotid vessels; type V, the segmental deletion of fat or fascial planes between tumor and CCA or ICA; and type VI, ill-defined CCA or ICA wall. They compared the CT findings with surgical evaluation and found evaluating tumor encasement of greater than 180 degrees of the circumference of the carotid vessels CT displayed a sensitivity, specificity, and accuracy of 18.5, 100, and 50%, respectively, and for evaluating partial fat or fascia deletion between tumor and CCA or ICA sensitivity, specificity, and accuracy was 90.9, 81.8, and 84.1%.

Stroke rates after unselected carotid artery ligation ranges from 15 to 45%. Associated mortality is as high as 58%.^{4,6} However, this rate can be significantly decreased with the use of performing a temporary balloon occlusion before attempted stenting.¹³ Though some investigators have proposed “stripping” or “peeling” the tumor off the carotid artery, accepting a subtotal resection, this has been associated with high recurrence rates.⁵ This is likely due to microinvasion of the adventitia and media in greater than 40% of these cases. Furthermore, “stripping” may weaken the arterial wall, especially after radiation therapy, predisposing the vessel to rupture.⁵ Though one patient

Table 1 Patient details

Subject	Age (years)	Radiation	Chemotherapy	Preoperative diagnosis	Vascular intervention	Vascular intervention date	Surgical treatment	Surgical treatment date	Complications	Follow-up (months)
1	83	Yes (preoperative)	Yes (preoperative)	Right neck SCC with ICA involvement	Right ICA/CCA stenting, right ECA embolization	June 10, 2015	Right radical neck dissection, right myofascial pectoralis major flap	July 2, 2015	None	1.5
2	65	Yes (preoperative)	Yes (preoperative)	Right laryngeal squamous cell carcinoma with transglottic and right CCA/ICA encasement	Right ICA/CCA stenting, right ECA embolization	May 21, 2015	Laryngopharyngectomy with right radical neck dissection, left modified radical neck dissection	May, 22, 2015	None	3.5
3	62	No	No	Right pharyngeal SCC with encasement of the right CCA/ICA	Right CCA/ICA stenting, left ECA embolization	May 15, 2015	Posterior pharyngotomy, mandibular swing procedure, left lateral pharyngotomy, left supraclavicular island flap for pharyngeal reconstruction	May 19, 2015	None	3.5
4	58	Yes (preoperative)	Yes (preoperative)	Right tonsillar SCC with right CCA/ICA involvement	Right CCA/ICA stenting, right ECA by embolization	May 4, 2015	Right radical neck dissection, pectoralis major flap	May, 14, 2015	Right ICA stent occluded, developed right sides Horner syndrome for right ICA occlusion	3.5
5	58	No	No	Transglottic SCC with CCA/ICA involvement	Right CCA/ICA stenting, right superior thyroidal embolization, right lingual artery embolization, right facial artery angiography and embolization	April 30, 2015	Pharyngolaryngectomy, right radical neck dissection, left modified radical neck dissection, and anterolateral thigh flap	May 2, 2015	Neck hematoma on postoperative d 2	3.5

Abbreviations: CCA, common carotid artery; ECA, external carotid artery; ICA, internal carotid artery; SCC, squamous cell carcinoma.

Fig. 5 (A) Patient with CCA and ICA encasement who underwent preoperative covered stent placement, followed by total laryngectomy, and bilateral modified radical neck dissection with dissection of adventitia from the covered stent. (B) The covered stent over the CCA/ICA just posterior to the surgical instrument. CCA, common carotid artery; ICA, internal carotid artery.

Fig. 6 The histopathological findings of a patient who underwent previous resection and radiation therapy, with recurrent squamous cell carcinoma of the neck and involvement of the ICA and CCA. The patient underwent radical neck dissection with pectoralis major flap transfer for coverage of the great vessels. (A) A representative sample of the specimen at low magnification ($\times 25$ original magnification) using hematoxylin and eosin staining displaying necrotic and viable tumor involving the adventitial margin. The external carotid artery with thrombus and tumor infiltrating its wall is seen in the middle. (B) The same view of the specimen, however, with a Verhoeff elastic stain showing tumor involving the adventitia of the ICA. Elastic stain highlights the disrupted elastic lamina of the adjacent external carotid artery which was removed in the neck dissection. CCA, common carotid artery; ICA, internal carotid artery.

sustained a cerebrovascular accident in our study, they did not have any major long-term deficit. The reason for the occurrence of their occluded stent cannot be accounted for as they did not have any major risk factors.

Alternatively, in an attempt to minimize ischemia-associated complications after carotid sacrifice, carotid replacement may be performed, using autogenous vein or artery versus synthetic grafts. Sessa et al showed good success in 30 patients undergoing replacement of the carotid artery with superficial femoral artery grafts, with only one patient reporting stroke.⁴ However, in a study by Wright et al that used saphenous vein grafts to replace the ICA following tumor resection in 20 patients, two strokes and one graft rupture were reported.⁶

Conclusion

Preoperative covered stent placement of the cervical ICA/CCA in the management of subjects with head and neck tumors who display encasement on preoperative imaging may represent a safe and effective treatment. A higher powered study with longer follow-up needs to be performed to assess the long-term benefit and morbidity of using this technique.

Note

This abstract has been accepted for presentation at the 26th Annual North American Skull Base Society Meeting, Scottsdale, AZ, 2016.

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