Carotid resection and reconstruction associated with treatment of head and neck cancer

Teresa R. Kroeker, MD, and John C. O'Brien, MD

Patients with head and neck cancer may experience carotid artery involvement. We present a series of 10 patients, all with stage IVB disease, who required carotid resection and reconstruction to achieve a complete resection. Nine of the 10 patients had previous radiation treatment to the neck. Six died of distant disease, and three died of other causes with no local or regional recurrences. Carotid resection and reconstruction can be done safely, achieving local and regional control.

Tumor involvement of the carotid artery is considered stage IVB disease with a grave prognosis. Kennedy reported a 7% 5-year survival, a 46% local recurrence rate if treated by methods other than resection, and a 56% to 68% rate of distant metastases (1). Interestingly, 18% of those with local recurrence die from uncontrolled disease in the neck, even in the absence of distant metastases, which is why we support an aggressive approach with stage IVB disease. Yet, resecting and reconstructing the carotid artery to obtain an R0 resection (R0 defined as no residual disease) remains a controversial issue and is dependent on the surgeon's philosophy and skills as well as the patient's desire and fortitude. Here we report our experience with carotid resection associated with treatment of head and neck cancer.

METHODS

To determine the outcomes of carotid resection during oncologic surgery, we conducted an institutional review board–approved retrospective chart review of patients who were treated between the years of 1995 and 2010. Data were evaluated for demographic information, type of surgery, complications, and mortality.

RESULTS

Ten patients between the years of 1995 and 2010 required carotid resection and reconstruction to obtain a complete oncologic resection (R0). The surgery was done by two head and neck surgeons at Baylor University Medical Center at Dallas along with five vascular surgeons from Baylor Heart and Vascular Hospital. As shown in *Table 1,* eight of the patients were men, and seven were >65 years old. All had squamous cell carcinoma with T4b lesions encasing or invading the carotid artery. Nine patients had previous neck radiation, while seven had a smoking history. Hypertension, coronary artery disease, and chronic obstructive pulmonary disease were the most common comorbidities. Eight carotid arteries were reconstructed using polytetrafluoroethylene (PTFE) graft, one using the cephalic vein, and one using the greater saphenous vein. Wound closure and vascular coverage were achieved with seven pectoralis flaps, one anterolateral thigh free flap, one radial free flap, and one primary neck closure.

Postoperative complications included osteonecrosis secondary to postoperative radiation at 5 years, stroke with hemiparesis secondary to occlusion of the PTFE graft with resolution of symptoms at 3 months, pseudoaneurysm of the PTFE graft at 23 months repaired with a greater saphenous vein interposition graft, cricopharyngeal spasms treated with serial balloon dilations and Botox injections, partial pectoralis flap loss secondary to a tracheostomy tie, neck abscess drained in the operating room, and a thigh hematoma after an anterolateral thigh free flap required drainage. None of the complications was life-threatening. All patients with complications had a history of radiation (except one patient who developed osteonecrosis secondary to postoperative radiation).

One patient is alive at 2 months with no evidence of disease (NED). Nine patients are dead; six died of distant metastases at 5, 8, 8, 13, 29, and 37 months, all with no local or regional recurrence *(Table 2).* The longest survivor died of vasculopathy at 138 months with NED. One died of cerebrovascular accident and esophageal cancer at 52 months with NED, and another died of necrotizing pneumonia at 4 months with NED.

DISCUSSION

Our data confirm that carotid resection and reconstruction can be performed safely when head and neck surgeons collaborate with vascular surgeons, resulting in improved survival without undue risk of stroke or death. A complete oncologic resection (R0) is achieved, and local and regional control of the disease is attained without sacrificing the patient's quality of life.

From the Department of Surgery, Baylor University Medical Center at Dallas.

Corresponding author: John C. O'Brien, MD, 1004 North Washington Avenue, Dallas, Texas 75204 (e-mail: Job8223@aol.com).

Table 1. Demographic information on 10 patients with head and neck cancer who had a carotid resection

Variable	Number (%)
Gender	
Male	8 (80%)
Female	2 (20%)
Age	
<50	1 (10%)
51–65	2 (20%)
>65	7 (70%)
Comorbidities	
Hypertension	6 (60%)
CAD	5 (50%)
COPD	4 (40%)
Alcoholism	2 (20%)
Diabetes	1 (10%)
Other heart disease	1 (10%)
History of CVA	1 (10%)
Surgical history	
CABG	3 (30%)
CEA	1 (10%)
Smoking history	
Yes	7 (70%)
No	3 (30%)
Prior radiation	
Yes	9 (90%)
No	1 (10%)
Primary tumor	
SCC	10 (100%)
Primary site	
Oropharynx	2 (20%)
Hypopharynx	2 (20%)
Larynx	3 (30%)
Unknown primary	1 (10%)
Stage	
IVB	10 (100%)

CAD indicates coronary artery disease; COPD, chronic obstructive pulmonary disease; CVA, cerebrovascular accident; CABG, coronary artery bypass grafting; CEA, carotid endarterectomy; SCC, squamous cell carcinoma.

Table 2. Survival of 10 patients with head and neck cancer who had a carotid resection

Survival	Number (%)
1 year	5 (50%)
2 year	4 (40%)
3 year	3 (30%)
4 year	2 (20%)
5 year	1 (10%)

Preoperative assessment for advanced head and neck disease includes ultrasound, computed tomography (CT), and magnetic resonance imaging (MRI). Ultrasound may show echoes between the mass and artery to be attenuated, a flattened artery, or luminal invasion of the tumor (2). There is a substantial risk of carotid involvement when CT shows 180-degree involvement or <1.8 mm separation between the mass and carotid (3). MRI has a sensitivity of 100% and a specificity of 88% in suggesting unresectability when >270 degrees of circumferential involvement is seen (4). Further imaging, including CT angiography and arteriography, is left to the discretion of the consulting vascular surgeon.

Do patients benefit from this aggressive approach of resecting and reconstructing the carotid artery? Without carotid resection, Roh in Korea evaluated patients who received chemoradiotherapy alone or palliative treatment for stage IVB disease, and none of the patients survived longer than 15 months (5). Snyderman's meta-analysis of 158 patients reported a 22% 2-year disease-free survival (6). Other studies have reported 1-year disease-free survival to be as high as 44% (7–9). Katsuno reported 40% to be free of disease at 2 years (10). The rate of distant metastases also decreased in the absence of recurrence in the neck (1).

Carotid resection and reconstruction can be done with an acceptable 5% stroke rate and 7% mortality rate, as reported in Katsuno's retrospective review of 148 patients (10). Ozer reviewed 18 patients and reported a combined stroke and mortality rate of 5.5%, while Freeman reported an overall perioperative mortality rate of 3% in a review of 58 patients (11, 12). Some reports show no significant difference of stroke risk in carotid artery ligation versus reconstruction (6, 13). Others show a 30% to 50% mortality rate and stroke incidence with elective ligation (7, 14). Meleca reported neurologic sequelae in 7 of 12 patients who underwent elective ligation versus 1 of 8 patients who underwent interposition graft reconstruction (15). Brennan reported a 29% mortality and stroke rate in seven patients who underwent resection and ligation of the carotid artery (16).

Multiple methods have been used to assess who will tolerate elective ligation of the carotid artery, including intraoperative electroencephalography, stump pressures, ocular plethysmography, somatosensory-evoked potentials in conjunction with stump pressures, and temporary balloon occlusion with zenon-enhanced CT of cerebral blood flow (17–20). No method is completely reliable, as most strokes occur 1 to 5 days after ligation secondary to ascending thrombosis from the ligated artery stump. Balloon occlusion tests have an unacceptable false-negative rate. Wright reported a stroke rate of 30% after a negative balloon occlusion test and a stroke rate of 10% after a balloon occlusion test with an adjunctive test such as electroencephalogram, single-photon emission CT, or transcranial Doppler scanning (21). Some have reported a better sensitivity when combining balloon occlusion tests with controlled

hypotension (22). These stroke rates are too high for a "safe" ligation, compared to a 5% stroke rate for resection and reconstruction in unselected patients.

The goal of oncologic surgical treatment is to achieve a complete resection (R0). When faced with carotid encasement or involvement, surgical options include resection and elective ligation of the carotid artery, peeling the tumor off the carotid, or resection with reconstruction of the carotid.

Peeling the tumor from the carotid artery has several pitfalls. First and foremost, since it is not an oncologic resection, microscopic residual tumor may be left on the vessel wall of the carotid artery (23). Huvos' examination of 64 resected carotid arteries found that 70% had involvement of the carotid wall or sheath with invasive squamous cell carcinoma (24). Peeling also compromises blood flow to the arterial wall, which weakens the wall, increasing the risk of carotid rupture (1, 25).

Reconstruction can be done using an autogenous vein, autologous artery, or prosthetic material such as PTFE graft. Jacobs argued that using the superficial femoral artery is superior to using vein because it tolerates infections well without the need for a pharyngostome or myocutaneous flap (26, 27). Sessa reviewed 30 patients, 43% with neck wound problems (28). After superficial femoral artery reconstruction, there were no failures or graft blowouts. Some argue that the greater saphenous vein has difficulty tolerating infection and should not be used in infected or radiated fields, but Reilly showed good results in infected and radiated fields using the greater saphenous vein for reconstruction with no vascular suture line disruptions in a 3- to 50-month follow-up (29). Wright also supports the use of the greater saphenous vein in cases with intraoperative contamination and radiated fields, with only one out of 20 patients having a graft blowout, treated by ligation without stroke (21). In our series of patients, three patients had resection of the pharynx or esophagus; one was reconstructed using PTFE, and two were reconstructed using autogenous vein (cephalic vein and greater saphenous vein). There were no graft blowouts in the face of these infected and radiated fields.

Our vascular surgeons prefer to use a prosthetic graft like PTFE with the thought that autogenous vein may dilate and become ectatic over time. Miao in China reported 13 cases using PTFE along with mycocutaneous flaps (30). One graft blowout secondary to a pharyngocutaneous fistula was treated with ligation, resulting in no neurological deficits. We believe that coverage of the reconstructed carotid artery with nonradiated muscle is important to prevent graft blowout. A pectoralis flap was used in 70% of our patients. Other options include sternocleidomastoid, pectoralis, trapezius, latissimus, and levator scapulae. One patient had a planned pharyngostome after emergent pharyngectomy for recurrent cancer with perforation and abscess with pseudoaneurysm of the carotid artery. PTFE was used for arterial reconstruction and covered with a pectoralis flap, and no infection or problems occurred for the 13 months of survival.

Although this is a small series of 10 patients, we have found that the collaboration of head and neck surgeons with vascular surgeons provides the patient with a complete oncologic resection and revascularization without undue risk of postoperative stroke. While the improvement in survival is minor, locoregional control of disease is obtained, and quality of life is improved.

1. Kennedy JT, Krause CJ, Loevy S. The importance of tumor attachment to the carotid artery. *Arch Otolaryngol* 1977;103(2):70–73.
2. Yonetsu K, Ikemura K. Ultrasonographic study of the relation of metastatic nodes to the carotid artery. *Head Neck Surg* 1987;9(5):279–283.
3. Yoo GH, Hocwald E, Korkmaz H, Du W, Logani S, Kelly JK, Sakr W, Jacobs JR. Assessment of carotid artery invasion in patients with head and neck cancer. *Laryngoscope* 2000;110(3 Pt 1):386–390.
4. Yousem DM, Hatabu H, Hurst RW, Seigerman HM, Montone KT, Weinstein GS, Hayden RE, Goldberg AN, Bigelow DC, Kotapka MJ. Carotid artery invasion by head and neck masses: prediction with MR imaging. *Radiology* 1995;195(3):715–720.
5. Roh JL, Kim MR, Choi SH, Lee JH, Cho KJ, Nam SY, Kim SY. Can patients with head and neck cancers invading carotid artery gain survival benefit from surgery? *Acta Otolaryngol* 2008;128(12):1370–1374.
6. Snyderman CH, D'Amico F. Outcome of carotid artery resection for neoplastic disease: a meta-analysis. *Am J Otolaryngol* 1992;13(6):373–380.
7. Lore JM Jr, Boulos EJ. Resection and reconstruction of the carotid artery in metastatic squamous cell carcinoma. *Am J Surg* 1981;142(4):437–442.
8. McCready RA, Miller SK, Hamaker RC, Singer MI, Herod GT. What is the role of carotid arterial resection in the management of advanced cervical cancer? *J Vasc Surg* 1989;10(3):274–280.
9. Okamoto Y, Inugami A, Matsuzaki Z, Yokomizo M, Konno A, Togawa K, Kuribayashi R, Ogawa T, Kanno I. Carotid artery resection for head and neck cancer. *Surgery* 1996;120(1):54–59.
10. Katsuno S, Takemae T, Ishiyama T, Usami SI. Is carotid reconstruction for advanced cancer in the neck a safe procedure? *Otolaryngol Head Neck Surg* 2001;124(2):222–224.
11. Ozer E, Agrawal A, Ozer HG, Schuller DE. The impact of surgery in the management of the head and neck carcinoma involving the carotid artery. *Laryngoscope* 2008;118(10):1771–1774.
12. Freeman SB, Hamaker RC, Borrowdale RB, Huntley TC. Management of neck metastasis with carotid artery involvement. *Laryngoscope* 2004;114(1):20–24.
13. Aslan I, Hafiz G, Baserer N, Yazicioglu E, Kiyak E, Tinaz M, Biliciler N. Management of carotid artery invasion in advanced malignancies of head and neck: comparison of techniques. *Ann Otol Rhinol Laryngol* 2002;111(9):772–777.
14. Watson WL, Silverstone SM. Ligation of the common carotid artery in cancer of the head and neck. *Ann Surg* 1939;109(1):1–27.
15. Meleca RJ, Marks SC. Carotid artery resection for cancer of the head and neck. *Arch Otolaryngol Head Neck Surg* 1994;120(9):974–978.
16. Brennan JA, Jafek BW. Elective carotid artery resection for advanced squamous cell carcinoma of the neck. *Laryngoscope* 1994;104(3 Pt 1):259–263.
17. Atkinson DP, Jacobs LA, Weaver AW. Elective carotid resection for squamous cell carcinoma of the head and neck. *Am J Surg* 1984;148(4):483–488.
18. de Vries EJ, Sekhar LN, Horton JA, Eibling DE, Janecka IP, Schramm VL Jr, Yonas H. A new method to predict safe resection of the internal carotid artery. *Laryngoscope* 1990;100(1):85–88.
19. Ehrenfeld WK, Stoney RJ, Wylie EJ. Relation of carotid stump pressure to safety of carotid artery ligation. *Surgery* 1983;93(2):299–305.
20. Martinez SA, Oller DW, Gee W, deFries HO. Elective carotid artery resection. *Arch Otolaryngol* 1975;101(12):744–747.
21. Wright JG, Nicholson R, Schuller DE, Smead WL. Resection of the internal carotid artery and replacement with greater saphenous vein: a safe procedure for en bloc cancer resections with carotid involvement. *J Vasc Surg* 1996;23(5):775–780.
22. Standard SC, Ahuja A, Guterman LR, Chavis TD, Gibbons KJ, Barth AP, Hopkins LN. Balloon test occlusion of the internal carotid artery with hypotensive challenge. *AJNR Am J Neuroradiol* 1995;16(7):1453–1458.

23. Maves MD, Bruns MD, Keenan MJ. Carotid artery resection for head and neck cancer. *Ann Otol Rhinol Laryngol* 1992;101(9): 778–781.
24. Huvos AG, Leaming RH, Moore OS. Clinicopathologic study of the resected carotid artery. Analysis of sixty-four cases. *Am J Surg* 1973;126(4):570–574.
25. Urken M, Biller HF, Lawson W, Haimov M. Salvage surgery for recurrent neck carcinoma after multimodality therapy. *Head Neck Surg* 1986;8(5):332–342.
26. Jacobs JR, Arden RL, Marks SC, Kline R, Berguer R. Carotid artery reconstruction using superficial femoral arterial grafts. *Laryngoscope* 1994;104(6 Pt 1):689–693.
27. Jacobs JR, Korkmaz H, Marks SC, Kline R, Berguer R. One stage carotid artery resection: reconstruction in radiated head and neck carcinoma. *Am J Otolaryngol* 2001;22(3):167–171.
28. Sessa CN, Morasch MD, Berguer R, Kline RA, Jacobs JR, Arden RL. Carotid resection and replacement with autogenous arterial graft during operation for neck malignancy. *Ann Vasc Surg* 1998;12(3):229–235.
29. Reilly MK, Perry MO, Netterville JL, Meacham PW. Carotid artery replacement in conjunction with resection of squamous cell carcinoma of the neck: preliminary results. *J Vasc Surg* 1992;15(2):324–329.
30. Miao B, Lu Y, Pan X, Liu D. Carotid artery resection and reconstruction with expanded polytetrafluoroethylene for head and neck cancer. *Laryngoscope* 2008;118(12):2135–2138.