Hypotensive endovascular test occlusion of the carotid artery in head and neck cancer

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Object. To evaluate the reliability of balloon test occlusion with hypotensive challenge (BTO and HC) as a predictor of neurological complications before internal carotid artery (ICA) sacrifice in patients with advanced head and neck cancer, the authors retrospectively reviewed the medical records of patients presenting to their institutions between 1992 and 1997 in whom this preoperative assessment was performed.

Methods. Eleven patients who were candidates for extended comprehensive neck dissection (ECND) and potential ICA sacrifice were included in the study. Eight patients tolerated the test and underwent endovascular occlusion or surgical ligation of the ICA before ECND (four patients), preservation of the ICA at the time of surgery (three patients), or palliative therapy (one patient). Of three patients in whom BTO and HC failed, one patient received palliative treatment only; the other two underwent ECND with preservation of the ICA. In the group of patients who passed the test and underwent ICA occlusion or ligation before ECND, fatal thromboembolic stroke occurred within 24 hours of permanent balloon occlusion in one patient, resulting in a combined neurological morbidity/mortality rate of 25% in this subset of patients and an overall complication rate of 9% in this series.

Conclusions. The authors found that BTO and HC offers a simple and reliable method of preoperative risk assessment when ICA resection is planned for regional control of disease in advanced head and neck cancer. This management option, however, is associated with a potential for neurological complication that must be weighed against the natural course of the disease and the risks and benefits of other treatment modalities.

KEY WORDS • balloon test occlusion • carotid artery • cerebral revascularization • head and neck cancer • skull base tumor

Nonsurgical management (chemo- and radiation therapy) of head and neck cancer is a promising clinical option.⁹ Tumor, however, may involve the ICA, threatening spontaneous CA rupture in patients with AHNC. In those patients for whom resection is indicated after nonsurgical management fails to control the disease or for those who choose surgery as the primary treatment of the disease, elective resection of the ICA may be necessary. Because of the potential for significant associated neurological complications, resection of the ICA is controversial.¹³ Current management options include the following: 1) ICA preservation with “peeling” of tumor from the vessel; 2) ICA resection after revascularization; 3) ICA occlusion and resection after an asymptomatic temporary test occlusion; and 4) palliative therapy.

With the advent of endovascular techniques, BTO and HC has been performed at our institutions to assess toler-

ance to ICA occlusion in patients with AHNC in whom there is imaging-based evidence of ICA involvement. After hypotensive endovascular test occlusion, permanent balloon occlusion or sacrifice of the ICA was performed when indicated, often as a separate procedure, before ECND and resection of the ICA. The objective of this study was to review our experience and evaluate the reliability of BTO and HC as a predictor of neurological outcome after CA sacrifice in AHNC.

CLINICAL MATERIAL AND METHODS

Patient Population

We retrospectively reviewed the medical records of all consecutive patients with a diagnosis of AHNC (Stage III/IV head and neck cancer according to the classification system of the American Joint Committee on Cancer) who presented to our institutions between 1992 and 1997. Those patients who underwent BTO and HC were included in the study. These patients underwent preoperative endoscopy and neuroimaging studies (CT and magnetic resonance imaging) and were candidates for ECND and

Abbreviations used in this paper: AHNC = advanced head and neck cancer; BTO = balloon test occlusion; CA = carotid artery; CT = computerized tomography; ECND = extended comprehensive neck dissection; HC = hypotensive challenge; ICA = internal CA.

potential ICA sacrifice because of neuroimaging-based evidence of ICA involvement with tumor.

In each case, the hospital record, operative report, and office notes were reviewed. Pertinent abstracted clinical data included demographic information, diagnosis and stage of disease, results of BTO and HC, and management protocol. Neurological complications induced by the hypotensive endovascular test occlusion, permanent balloon occlusion, or surgical ICA ligation were recorded.

Eleven patients were identified. There were 10 men (mean age 59.9 years, range 35–70 years) and one woman (age 62 years). High-grade mucoepidermoid carcinoma was present in one patient, whereas squamous cell carcinoma was present in 10; there was no evidence of metastatic disease in any patient at the time of the test occlusion or operation. Disease was confined to the head and neck area at the time of BTO in all patients.

Endovascular Balloon Test Occlusion

Balloon test occlusion was performed with HC. This method has been previously described and is outlined only briefly here.¹⁴ Routinely, patients were brought to the angiography suite and given dexamethasone and nimodipine for cerebral protection. The procedure was performed after induction of neuroleptanalgesia.¹⁴ Systemic anticoagulation was achieved using heparin and maintained at activated coagulation times that were two to three times the baseline values. A diagnostic four-vessel cervical and cerebral angiographic study was initially performed to exclude significant cerebrovascular abnormalities and to evaluate the collateral circulation. Selective catheterization of the ICA of interest was then performed with either a Swan-Ganz balloon catheter (in most patients) or a non-detachable silicone balloon catheter (Boston Scientific, Boston, MA). The distal port of the Swan-Ganz catheter was perfused with heparinized saline. Testing was begun by inflating the Swan-Ganz catheter or silicone balloon to occlude the ICA. Carotid artery occlusion was confirmed by angiography. Tolerance to test occlusion was assessed by detailed neurological examinations performed every 5 minutes. A test occlusion was considered positive if any new neurological deficit developed, except that of decreased ipsilateral eye acuity. If the patient tolerated 20 minutes of balloon occlusion under normotensive conditions, hypotension was induced by infusing sodium nitroprusside (2.5–7.5- μ m/kg body weight/min). Mean arterial pressure was reduced to two thirds of baseline, and hypotension was maintained for an additional 20 minutes. The balloon was then deflated, and heparinization was reversed using intravenous protamine. The test was discontinued immediately if a new neurological deficit developed during any phase of the test.

Permanent occlusion of the ICA was performed as a separate procedure with either detachable silicone balloons or ligation at surgery. Endovascular occlusion was performed within the cavernous ICA as distally as possible to avoid the formation of thrombus and subsequent thromboembolic phenomena. Except in one patient anticoagulation heparin-based therapy was continued with activated coagulation times maintained at two times the baseline value for 24 hours. Surgical ligation of the ICA was performed at the level of the skull base during the ECND.

RESULTS

Figure 1 shows the results of BTO and HC and subsequent patient management. Eight of the 11 patients passed the test uneventfully and were therefore neurologically cleared to undergo ICA resection. Of these eight patients, one patient declined surgery and received palliative therapy only; three patients underwent ECND with preservation of the ICA because intraoperatively no gross involvement of the vessel by tumor was observed; three underwent ECND and ICA resection; and one patient underwent ligation and resection of the ICA at the time of ECND because of tortuous ICA anatomy that precluded permanent preoperative endovascular sacrifice.

Of three patients in whom BTO and HC failed, one patient received palliative treatment only. The other two patients underwent ECND with preservation of the ICA.

A fatal middle cerebral artery stroke occurred in one patient who passed the BTO and HC. Heparin-based anticoagulation was limited to the immediate perioperative period in this patient. The neurological complication rate associated with ICA occlusion or ligation after BTO and HC was 25% (one of four patients treated with ICA occlusion after a negative test). The overall neurological morbidity/mortality rate associated with treatment was 9%. Among patients in whom BTO and HC failed, neurological deficits resolved promptly after deflation of the endovascular balloon. No patient suffered permanent neurological impairment related to BTO and HC.

DISCUSSION

We have previously reported on the effectiveness of HC to enhance the sensitivity of BTO.¹⁴ The predictive value of a negative test occlusion was 94% for all methods of CA occlusion. Reported false-negative rates, however, may be as high as 15%, primarily as the result of delayed hemodynamic complications.⁴ Several adjunctive procedures other than HC have been used in an attempt to enhance the sensitivity of BTO. The most widely used are regional blood flow studies including transcranial Doppler ultrasonography, single-photon emission CT, and, more recently, xenon-enhanced CT.^{2,5,6,12,15,16} At present, no pretesting method exists to eliminate completely the potential neurological complications after permanent CA occlusion.¹¹ Variations of the BTO have become specific to individual institutions, guided by the availability of equipment and technical support. We prefer the technique of HC as an adjunct to BTO because it is simple to perform and requires no additional imaging equipment.

Concurrent treatment with chemotherapy and radiotherapy offers exciting clinical management strategies for AHNC patients in whom the pathological lesions can be resected. It also offers many new clinical scenarios that must be addressed in the management of these patients. One such challenge is the case in which a complete response occurs at a primary disease site but in which residual disease regionally encompasses the CA. Similarly, cases in which AHNC is unresponsive to adjuvant therapy and in which there is associated ICA involvement pose a management dilemma. Without treatment, the 1-year survival rate in this population is estimated to be below 5%.¹⁰

Traditionally, cancer involving the ICA has been man-

Fig. 1. Flow chart showing results of hypotensive test occlusion and subsequent patient management.

aged by peeling the tumor from the CAs (that is, CA preservation). In a seminal clinicopathological study in which CAs were resected in 64 patients with advanced cervical cancer, Huvos, et al.,⁷ however, discovered microscopic invasion of the vessel wall or the periarterial fascia in 40 to 60% of cases. It is therefore not surprising that peeling tumor from the CAs is often associated with a high rate of regional disease recurrence. Kennedy, et al.,⁸ treated 20 of 28 patients with cervical cancer by peeling tumor from the CAs. These authors reported a regional recurrence rate of 46% and distant metastasis rate of 67%.

We present a patient-tailored approach for managing cases of AHNC being considered for ECND in which ICA involvement potentially necessitates vascular resection. First, the ability to tolerate ICA occlusion is evaluated by BTO and HC in all patients. Permanent occlusion of the CAs is performed in those patients who have passed the BTO test and who are surgical candidates. By following this management strategy, the perioperative neurological complication rate associated with permanent CA occlusion or resection after a negative BTO and HC was 25% (one fatal embolic stroke among four patients). Nayak, et al.,¹⁰ reported a postoperative neurological complication rate of 33% and a mortality rate of 17% in 18 patients who underwent ICA resection for malignant disease. Conversely, Brisman, et al.,³ reported poor patient outcome after applying this management protocol, with two of three patients suffering major postoperative strokes and no survivors at 6 months. In the protocol presented here the clinical concerns raised by Brisman, et al., are addressed by avoiding permanent ICA occlusion in those patients with a positive BTO and HC. We believe that the mechanism of middle cerebral artery stroke in one of four patients undergoing permanent ICA occlusion was facilitated by the lack of continued heparin anticoagulation beyond the immediate postocclusion period. With prolonged anticoagulation therapy for 24 hours after balloon occlusion, we have significantly reduced the incidence of thromboembolic complications after permanent ICA occlusion in this patient population.

In our study, no complications were associated with BTO under normotensive or hypotensive conditions. Our

intent was not to establish the effect of our treatment protocol on survival in patients with AHNC. The small size of the study and limitation in follow-up data did not permit any meaningful statistical analysis with respect to disease recurrence or long-term survival. Adams, et al.,¹ however, reported the results of elective BTO and HC before permanent ICA occlusion in 20 patients with recurrent AHNC. The mean survival in 15 patients treated successfully by permanent ICA occlusion was 13 months, with two patients surviving more than 2 years. Although no patient was cured of disease, spontaneous CA rupture did not occur in 14 of the patients. We realize that survival benefit remains unproven in this setting; however, improved local disease control due to resection may prove to have survival advantage. Such conclusions are beyond the scope of this paper but remain of clinical importance.

CONCLUSIONS

Involvement of the ICA in AHNC poses a difficult therapeutic challenge, one that is often controversial. With increasing clinical potential for regional control of disease, BTO and HC offers a simple and reliable preoperative assessment of neurological risk in patients deemed appropriate for ECND and ICA resection.

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