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Combined Balloon Test Occlusion and SPECT Analysis for Carotid Sacrifice: Angiographic Predictors for Success or Failure?

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Abstract

Objectives To evaluate angiographic patterns that may predict the success or failure of carotid artery balloon test occlusion (BTO) and single-photon emission computed tomography (SPECT) analysis for carotid sacrifice.

Study Design This is a retrospective nonrandomized study.

Study Setting Conducted at the University of California Davis Medical Center, Sacramento, California.

Patients A total of 31 patients, ranging from 24 to 83 years of age, with a mean age of 61 years (22 men, 9 women) with head and neck cancer (26 patients), malignant glomus tumor (1 patient) or giant carotid aneurysms (4 patients) as possible candidates for surgical carotid artery sacrifice were evaluated from September 2005 to September 2012.

Methods All patients underwent unilateral internal carotid artery balloon test occlusion with SPECT analysis (20 mCi technetium 99m-hexamethyl propyleneamine oxime [HMPAO]) imaging before and during carotid occlusion. Carotid angiography with carotid cross-compression (manual compression of the cervical artery contralateral to the side of contrast injection) was used to analyze filling through the anterior communicating artery to the contralateral hemisphere.

Intervention The balloon occlusion was terminated in two patients because of deterioration of the neurologic exam.

Main Outcome Measures All patients who passed the neurologic examination during BTO and also passed the SPECT occlusive study underwent successful carotid sacrifice without neurologic sequelae. Patients failing the occlusive neurologic examination and/or the SPECT study elected chemoradiation, with the exception of one patient who underwent a successful carotid bypass graft and carotid resection.

Results The success of carotid sacrifice in patients passing both the occlusive test and the SPECT analysis for carotid sacrifice was 100%. Three patients failed both the BTO and the SPECT, with two demonstrating no anterior circulation cross-fill, but one showed some cross-fill. Six additional patients passed the BTO but failed the SPECT, with poor

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- ▶ occlusion
- ▶ sacrifice

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cross-fill in five patients. In addition, three patients who had excellent cross-fill through the anterior communicating artery to the contralateral hemisphere failed the SPECT examination in two cases and failed both tests in another case.

Introduction

Some head and neck tumors, as well as certain vascular pathologies, may necessitate carotid artery sacrifice in an attempt at cure. Various tests of the ability of a particular patient to withstand such a procedure without neurologic sequelae have been developed, from Xenon perfusion studies to transcranial Doppler, in conjunction with balloon test occlusion (BTO) of the artery for possible surgical removal.¹⁻¹⁹

We analyzed 31 consecutive patients who underwent simultaneous BTO and single-photon emission computed tomography (SPECT) analysis to attempt to see if angiographic patterns are sufficient to predict the success or failure of such techniques.

Materials and Methods

A total of 31 consecutive patients underwent internal carotid BTO using a 7 × 7 mm HyperForm balloon catheter (Covidien Inc., Minneapolis, United States), introduced through a 5F femoral arterial sheath and matched Envoy guide catheter (DePuy Synthes, West Chester, Pennsylvania, United States). Neurologic testing (motor, touch sensation, language, memory, judgment tests) was undertaken at 3-minute intervals during such occlusion. Occlusion was verified by contrast injected through the guide catheter. After 5 minutes of occlusion, 20 mCi of technetium 99m-hexamethyl propyleneamine oxime (HMPAO) was injected intravenously. Pre- and post-BTO SPECT imaging was undertaken. The SPECT analysis was considered abnormal and significant if there was a 10% change from pre- to post-BTO. Overall, 31 consecutive BTOs (9 women, 22 men; mean age 61 years) were evaluated from September 2005 to September 2012. Cross-filling during angiography pre-BTO was analyzed.

Results

Three patients failed both the BTO and the SPECT, with two demonstrating no anterior circulation cross-fill, but one showed some cross-fill. Six additional patients passed the BTO but failed the SPECT, with poor cross-fill in five patients. Eight of these nine patients did not have surgical resection or bypass but were treated with chemoradiation. One patient did have a surgical bypass and had no neurovascular complication. In addition, three patients had excellent cross-fill through the anterior communicating artery to the contralateral hemisphere but failed the SPECT examination in two cases and failed both tests in another case.

Twenty-two patients passed both the BTO and the SPECT. Thirteen of these patients had carotid sacrifice without

complication. The remaining patients chose chemoradiation without surgery.

Discussion

BTO as a diagnostic trial for possible carotid artery sacrifice in cases of head and neck cancer, as well as giant carotid aneurysms, is a well-established prognostic tool. BTO has been proposed by itself as a preoperative evaluation¹⁻⁵ but has also been paired with additional testing such as hypotensive challenge,^{6,7} xenon-enhanced computed tomography,⁸⁻¹⁰ 99mTc-HMPAO SPECT,¹¹⁻¹⁶ and transcranial Doppler ultrasonography.¹⁷⁻¹⁹

Our institution, based on published data, has chosen the BTO to be accompanied by SPECT to provide the greatest preoperative assessment of success without neurovascular complication after carotid sacrifice. However, Segal et al suggested that BTO combined with SPECT is not perfect in predicting success following carotid sacrifice, and they concluded that revascularization should be considered to minimize the likelihood of a stroke.¹¹

Our data suggest that patients successfully passing both BTO and SPECT are unlikely to suffer neurologically damage after carotid sacrifice. Our study also suggests that although the lack of significant anterior circulation cross-filling angiographically is often predictive of failure of BTO, SPECT, or both, three cases with cross-filling failed with BTO, SPECT, or both.

However, manual compression of the cervical carotid contralateral to the side of pathology and BTO may not be entirely reliable, due to the difference in force of compression from one examiner to the other and the effect of noncontrast opacified collateral circulation. Originally proposed by Valavanis, the injection by a second catheter of contrast material into the contralateral internal carotid artery during BTO can add additional information and may yield a predictive value of up to 98%. A delay in visualization of the occluded hemisphere veins by > 2 s may indicate the possibility of postcarotid sacrifice ischemia/stroke.⁴ However, the introduction of a second catheter and the additional contrast injection does add to the overall procedure time and risk for the BTO procedure.

Thus although the angiographic pattern of lack of cross-filling through the anterior communicating artery should alert the neuro-angiographer to the potential of BTO and/or SPECT failure, the angiographic pattern is not foolproof in predicting success or failure of this diagnostic/prognostic regimen. Contralateral contrast injection with a second catheter may be of additional benefit in the predictive value of BTO/SPECT for carotid sacrifice.

Finally, an additional drawback of this study is the non-randomized nature of patient selection. A total of 46% of patients in this group chose nonoperative therapies, and of course, the latter group's response to BTO and subsequent surgery cannot be assessed. Further, a selection bias of operative versus nonoperative patients cannot be assessed.

Notes

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