Permissive Hypertension during Awake Eversion Carotid Endarterectomy: A Physiologic Approach for Cerebral Protection

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BACKGROUND: Carotid endarterectomy (CEA) is often completed with general anesthesia and routine shunting; however, shunting is only required in a small group of at-risk patients to maintain adequate cerebral perfusion. Selective shunting during CEA is performed to normalize cerebral hemodynamics for patients determined to be at risk. Eversion CEA with selective shunting for neurologic dysfunction in patients that are awake/sedated is described, as well as routine use of permissive hypertension (PH), which uses standard cardiovascular medications to recruit the cerebral collateral network and reduce the need for shunting.

STUDY DESIGN: A retrospective review of all CEA procedures performed from July 2006 to April 2013 was conducted. Procedures were divided into 3 groups: pre-PH phase (group A), PH-test phase (group B), and routine PH phase (group C). Operative reports and anesthesia documentation were reviewed for clamp time, need for shunting, and mean hemodynamics during each case.

RESULTS: During the study period, 232 CEAs met inclusion criteria and were divided into 3 groups: group A ($n = 75$) was predominate reactionary shunting, group B ($n = 41$) was predominate reactionary blood pressure augmentation, and group C ($n = 116$) was pre-emptive PH. When combining groups A and B, the at-risk group consisted of 21 of 116 (18.1%) patients who had a neurologic compromise develop after clamping the internal carotid artery and required a shunt or altered blood pressure hemodynamics. In comparison with group C, routine use of PH pre-emptively before clamping as a standard intraoperative technique led to need for shunting in 1 of 116 (0.86%) ($p \leq 0.001$) and significantly reduced operative time ($p \leq 0.0001$).

CONCLUSIONS: Routine use of PH during clamp time can recruit the cerebral collateral network and substantially reduce the at-risk group and need for shunting in awake/sedated patients. (J Am Coll Surg 2014;218:760–767. © 2014 by the American College of Surgeons)

Standard surgical practice for cerebral perfusion during carotid endarterectomy (CEA) often uses general anesthesia and routine shunting to normalize cerebral hemodynamics. Selective shunting can be considered during CEA when temporary clamping of the carotid artery induces cerebral hypoperfusion. Shunting is recommended in the setting of low cerebral stump pressures, altered cerebral oximetry, and abnormal electroencephalogram changes, as well as in patients with neurologic changes occurring when awake/sedated.[1,2] These patients are at risk for perioperative cerebral ischemic events and have higher stroke rates if the cerebral collateral perfusion pressure (CCPP) is not restored by intraoperative shunting.[1,3,4] However, shunting has inherent risks and is unnecessary in approximately 85% of cases, with potential for distal dissection, embolization, acute occlusion, increased duration of the procedure, and technical interference with the distal repair.[1,5] It is apparent that maintaining adequate and stable CCPP in the at-risk group of patients is required to reduce perioperative stroke risk and, if shunts are not used, then augmentation of the CCPP can only be accomplished by intraoperative manipulation of mean arterial pressure by cardiovascular medications. Permissive hypertension (PH) is a temporary intraoperative process during carotid clamp time of

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Abbreviations and Acronyms

CCPP = cerebral collateral perfusion pressure
CEA = carotid endarterectomy
ICA = internal carotid artery
PH = permissive hypertension
SBP = systolic blood pressure

altering cerebral hemodynamics by standard vasoactive medications to maintain adequate CCPP, which reduces the need for shunting. This technique, with the combination of local/regional anesthesia with sedation, during eversion CEA is described.

METHODS

We performed a retrospective review of hospital records of all consecutive patients undergoing CEA by the primary author from February 2006 until April 2013. Records were reviewed for patient demographics, preoperative and postoperative symptoms, neurologic history of asymptomatic or symptomatic disease, and contralateral carotid status. Operative notes were reviewed for technique and perioperative events, and inadequate information led to exclusion from the study. Operative documentation was also reviewed for clamp time, need for shunting, and mean hemodynamic measurements. Indications for carotid endarterectomy were either carotid with stenosis of >50% and a neurologic event or, for those that were asymptomatic, a stenotic lesion measuring >70% based on duplex ultrasound consensus criteria.[6] Institutional Review Board authorization was granted for this study.

Procedure

All CEAs were performed using the eversion technique as described by Kieny and colleagues.[7] All CEAs were performed with the patient awake and with local/regional anesthesia with sedation. The patient was placed in a lounge chair position, with the neck angled no more than 15 degrees off the plane of the floor and the head taped to the bed at 45 degrees to the opposite wall. A Mayo stand was placed over the head of the patient to allow space for the anesthesiologist to easily assess the patient's neurologic status and prevent drapes from touching the face of the patient. Intraoperative ultrasound was used to locate the common carotid artery and the bifurcation and the planned incision was marked on the neck. In >95% of patients, the incision was placed within a major transverse skin fold approximately 4 cm in length directly over the carotid bifurcation. A subinduction dose of propofol 50 to 100 mg was given in addition to an infusion of dexmedetomidine 0.7 to 1.0 mg/kg/h to allow for local subcutaneous block of a 1:1 mixture of lidocaine 1% and bupivicaine 0.5% without epinephrine. A deep cervical block was then performed directly after each successive layer was exposed to the carotid where the carotid body was anesthetized. Heparin 5,000 U was administered intravenously by anesthesia personnel and dissection of the common, internal, and external carotids was completed. In cases using PH, the systolic blood pressure (SBP) was driven to 200 mmHg with phenylephrine before clamping the distal internal carotid artery (ICA). The operating room nurse monitored each patient's neurologic function by asking the patient to squeeze the contralateral hand during the endarterectomy. In addition, each patient was instructed to maintain a verbal countdown as the vessel was clamped. During CEA, those patients who, when clamped, demonstrated a temporary neurologic deficit that was unresponsive to blood pressure manipulation were shunted. Protamine sulfate was not administered at the conclusion of the CEA. Blood pressure measurements were recorded by anesthesia before, during, and after clamping, and mean values were calculated for each case.

Clinical metrics

Charts were reviewed for follow-up data. Patient follow-up included an initial 2-week postoperative visit, and then again at 1 month, and every 6 months for 2 years. Early study end points included technical success, placement of shunt, and perioperative neurologic or cardiac morbidity and mortality. Long-term end points were defined as a neurologic event, substantial restenosis requiring operative intervention, or death. Each visit included a history and physical examination and carotid duplex ultrasound. Patients were divided into 3 groups. Patients in group A underwent CEA before a PH protocol was instituted. Patients in group A predominantly underwent shunting as the first-line therapy for neurologic compromise. Patients in group B underwent CEA in a testing phase where reactive blood pressure augmentation rather then direct shunting was used for clamp-time temporary neurologic compromise. Patients in group C underwent CEA with full implementation of a preemptive PH protocol to prevent the need for carotid shunts.

Statistics

A statistical analysis was performed using IBM SPSS software, version 21. Chi-square analysis was used to determine the effect of the contralateral carotid percent stenosis as a predictor for altered hemodynamic requirements and was also used to detect significance for the use of shunts among the treatment groups.