Journal of Clinical Anesthesia (2011) **23**, 657–660

ELSEVIER

Journal of Clinical Anesthesia

Case report

Potential adverse effects of norepinephrine on cortical somatosensory-evoked potentials during carotid endarterectomy: a case report

Philip David Bamberger MD (Senior Attending Anesthesiologist)[a,*], Sedat Ulkatan MD (Neurophysiologist)[b], Estela Lladó Carbó MD (Neurophysiologist)[b], Vedran Deletis MD, PhD (Director)[b], Alan I. Benvenisty MD, FACS (Director of Transplant Surgery)[c]

[a]*Department of Anesthesiology, St. Luke's-Roosevelt Hospital Center, New York, NY 10019, USA; and College of Physicians & Surgeons, Columbia University, New York, NY 10036, USA*
[b]*Division of Intraoperative Neurophysiology, Hyman-Newman Institute for Neurology and Neurosurgery, St. Luke's-Roosevelt Hospital Center, New York, NY 10019; and College of Physicians & Surgeons, Columbia University, New York, NY 10036*
[c]*Department of Surgery, St. Luke's-Roosevelt Hospital Center, New York, NY 10019; and College of Physicians and Surgeons, Columbia University, New York, NY 10036*

Received 9 October 2009; revised 6 December 2010; accepted 23 December 2010

Keywords:
Carotid endarterectomy;
Neurophysiologic monitoring;
Norepinephrine;
Somatosensory-evoked potentials

Abstract The cerebral metabolic and vascular effects of intravenous norepinephrine have been shown in an animal model using somatosensory-evoked potentials (SSEPs). A case of intravenous norepinephrine resulting in a decrease in SSEP amplitude (of greater than 50%) despite no significant change in blood pressure, prior to cross-clamping during a carotid endarterectomy is presented. This finding may have implications for the use of norepinephrine in the critical care unit as well as the operating room.

1. Introduction

Neurophysiologic monitoring using electroencephalography (EEG) and/or somatosensory-evoked potentials (SSEPs) is often performed during carotid endarterectomy during general anesthesia. Sensitivity for predicting brain ischemia during the period of carotid cross-clamp is estimated to be approximately 90% [1]. Somatosensory-evoked potentials recorded from the ipsilateral (at risk) hemisphere while at the same time stimulating the contralateral median and ulnar nerve may assess adequacy of perfusion to the cerebral cortex at risk, whereas SSEPs recorded from the contralateral hemisphere to the carotid endarterectomy serve as a control for the nonsurgical effects of general anesthesia. Insufficient collateral blood flow due to brain ischemia may be indicated by a precipitous drop in the amplitude of the median nerve SSEP and EEG asymmetry. Somatosensory-evoked potentials and EEG may be affected by other variables as well,

* Correspondence: Philip David Bamberger, MD, Department of Anesthesiology, St. Luke's-Roosevelt Hospital Center, 1000 Tenth Ave., New York, NY 10019, USA.
E-mail address: philb99@optonline.net (P.D. Bamberger).

0952-8180/$ – see front matter © 2011 Elsevier Inc. All rights reserved.
doi:10.1016/j.jclinane.2010.12.029

changes in SSEP prior to carotid cross-clamp that may have resulted from administration of norepinephrine is presented.

2. Case report

The patient was a left-handed, 71 year old woman who first presented to the hospital 8 months earlier with left upper extremity weakness and left-sided neglect, which resolved over several days. Workup at the time included magnetic resonance imaging, which showed multiple, new, small, right-sided temporal-occipital lobe infarctions and an old frontal-parietal infarct. A carotid Doppler duplex scan at that time showed bilateral carotid stenoses of 80% to 99% with internal carotid artery (ICA) blood flow velocities of 582/156 cm/sec on the right and 360/140 cm/sec on the left. Consequently, she underwent successful, uneventful right carotid endarterectomy 8 months prior to this case presentation. At that time, relative hypertension during intraoperative cross-clamp was achieved with phenylephrine. There were no observed SSEP abnormalities intraoperatively.

Her past medical history was also significant for hypertension, coronary artery disease, two previous myocardial infarctions, hepatitis C, and renal insufficiency secondary to renal artery stenosis. She had undergone successful renal artery angioplasty and her creatinine levels had returned to approximately normal.

On this admission, preoperative carotid duplex examinations showed < 40% stenosis of the postoperative right carotid with normal flow velocities and 80% to 99% stenosis of the left with flow velocity of 360/140 cm/sec. Preoperative workup included a negative dobutamine stress echocardiogram. Electrocardiogram showed nonspecific lateral lead (I, L, V5, V6) ST changes. The chest radiograph was remarkable for cardiomegaly. Hematocrit was 36.4% and creatinine 1.4 mg/dL, and the rest of her laboratory values were within normal limits. Preoperative medications, all taken orally daily, were aspirin 81 mg, hydrochlorothiazide 12.5 mg, nifedipineXR 90 mg, metoprolol 100 mg, telmisartan 40 mg, and rosuvastatin 20 mg.

The patient was taken to the operating room where standard monitors were placed. Anesthesia was induced with fentanyl 250 μg and propofol 150 mg, and the trachea was intubated after administration of succinylcholine 100 mg. Anesthesia was maintained with total intravenous anesthesia (TIVA) of propofol 150 μg/kg/min, remifentanil 0.2 μg/kg/min, and phenylephrine 20 μg/min. Inhaled gases and ventilation were maintained with an air/oxygen mixture to produce an inspired oxygen concentration of 0.40 and end-tidal CO_2 of 32-33 mmHg. Left radial arterial and bladder catheters were inserted. Neurophysiologic monitoring included SSEPs elicited from right and left median nerves, right ulnar nerve, and bilateral posterior tibial nerves; motor-evoked potentials (MEPs) were elicited by transcranial electrical stimulation and recorded from right and left adductor pollicis brevis and right arm extensors. A two-channel EEG was also monitored.

After dissection of the carotid artery and harvesting of a femoral vein graft patch the patient was anticoagulated with 5,000 units of heparin. Induced hypertension was initiated with a progressive, incrementally increasing infusion of phenylephrine. The goal was to achieve a systolic blood pressure (SBP) 20% to 30% above the preoperative SBP (130-140 mmHg). In this case, SBP above 180 mmHg was desired as the "target" pressure. The patient's blood pressure (BP) did not respond to an increasing infusion of phenylephrine up to 200 μg/min. No changes in SSEP, MEP, or EEG were noted. It was decided then to substitute norepinephrine for phenylephrine so as to create relative hypertension in this patient. An infusion of norepinephrine was started at 4 μg/min and titrated up to 8 μg/min, when it was observed that the SSEP signals began to change bilaterally. During the attempt at induced hypertension with the norepinephrine infusion, bilateral upper extremity median nerve SSEP amplitudes decreased significantly (> 50%) (Fig. 1). The lower extremity SSEPs exhibited similar changes, although not as significant (< 50%) (Fig. 2).

Electroencephalography and MEPs were unchanged. These changes continued for approximately 40 minutes while the dosage of norepinephrine infusion was incrementally increased in an unsuccessful attempt to create a SBP of approximately 180 mmHg. It was then suspected that the norepinephrine infusion was having a deleterious effect on brain perfusion; it was discontinued in favor of phenylephrine at 200 μg/min, and BP of 140-160 mmHg was deemed sufficient. The SSEP signals returned to baseline in about 15 to 25 minutes without further surgical intervention or repositioning of the patient, and the operation proceeded without incident. After cross-clamping of the common, external, and internal carotid arteries, the internal carotid artery (ICA) was briefly unclamped to show vigorous pulsatile back bleeding, and no further alteration of the SSEPs was noted. The operation proceeded to completion; the patient was awakened without problem. The patient was discharged on postoperative day 1 neurologically intact.

3. Discussion

Norepinepherine is a vasopressor having inotropic, chronotropic, and vasoconstrictor activity with both alpha and beta sympathetic agonist activity [2]. However, unlike phenylephrine, which has primarily alpha-agonist activity [2], norepinephrine also increases cerebral metabolic oxygen consumption ($CMRO_2$) in rats [3]. We present electrophysiological evidence of adverse cerebral effects of norepinephrine, reversible in nature, induced just prior to carotid cross-clamping in a human subject. At a relatively "normal" systemic BP (140-160/55-65 mmHg) the patient developed