Posterior tibial nerve and median nerve somatosensory evoked potential monitoring during carotid endarterectomy

Purpose: Somatosensory evoked potential (SSEP) monitoring using the median nerve (MN) modality during carotid endarterectomy is well established. This study assessed the usefulness of monitoring the posterior tibial nerve (PTN) SSEP as an adjunct to MN SSEP for detection of cerebral ischemia and as an indicator for the insertion of a shunt in patients undergoing a carotid endarterectomy.

Methods: All patients undergoing carotid endarterectomy during three years who had routine bilateral MN SSEP were also monitored with bilateral PTN SSEP. Patients received a shunt if there was a significant change (> 50% decrease in amplitude of cortical peak (N20) in the MN SSEP after cross clamping. The incidence, timing, and duration of all PTN SSEP changes were compared to MN SSEP changes.

Results: One hundred fifty-three patients were studied. Significant changes in MN SSEP after cross clamping lead to insertion of a shunt in six patients. Changes in PTN SSEP occurred at almost the same time in three patients, four minutes before MN SSEP in one, three minutes later in one and no change in one patient. Good quality baseline tracings were obtained in 99% MN SSEP as compared to 88% PTN SSEP (P < 0.05). New postoperative neurological deficits occurred in four patients (2.6%), only one had significant evoked potential changes.

Conclusion: Monitoring of PTN SSEP is feasible and may be considered for an adjunct to MN SSEP or as an alternative modality if there are difficulties with MN SSEP. However, there may be a greater incidence of poor quality baseline tracings for PTN SSEP.
The use of somatosensory evoked potential (SSEP) monitoring during carotid endarterectomy is well established in many institutions.1-17 SSEP monitoring helps to assess the adequacy of collateral circulation during cross clamping of the carotid artery and the need for insertion of a shunt. Median nerve SSEP (MNSSEP) reflects the activity of the primary sensory cortex, which is supplied by the middle cerebral artery. As occlusion of the carotid artery will affect the blood supply to this area, the SSEP modality used during carotid endarterectomy has traditionally been the MN.1-17 During a transient ischemic attack (TIA) or a stroke, patients usually exhibit neurological deficits involving the upper extremity but may also have deficits of the lower extremity. Posterior tibial nerve SSEP (PTNSSEP) monitoring has been used as a monitor of the anterior cerebral artery territory.18 This area may also be affected during the occlusion of the carotid artery. The purpose of this study was to assess the usefulness of monitoring the PTNSSEP as an adjunct to MNSSEP for detection of cerebral ischemia and as an indicator for the insertion of a shunt in patients undergoing a carotid endarterectomy.

Methods
With the approval of the local Ethics Board, all patients undergoing a carotid endarterectomy during a three-year period (2000–2003) were studied. In our institution it is standard practice to monitor all patients during their carotid endarterectomy with bilateral MNSSEP. A shunt is inserted if there is a greater than 50% decrease in the amplitude of the cortical N20 peak after cross clamping of the carotid artery. The surgical procedure was conducted in a standard fashion as determined by each surgeon. In addition to bilateral MNSSEP all patients were monitored with bilateral PTNSSEP. No clinical action was taken based on the PTNSSEP monitoring.

All patients received a general anesthetic as determined by the attending anesthesiologist. In addition to standard monitors, an intra-arterial catheter was used for blood pressure measurements. The anesthetic management included the induction of anesthesia with fentanyl, propofol, and rocuronium. Maintenance consisted of nitrous oxide, fentanyl, rocuronium, and isoflurane, sevoflurane, or desflurane. Muscle paralysis was maintained. Blood pressure was maintained at the patient’s preoperative normal level and any hypotension was treated with vasopressors, (phenylephrine, ephedrine) and bradycardia was treated with atropine. The temperature and PaCO₂ of the patient were both maintained within a normal range. A trained technologist performed all evoked potential monitoring. The equipment used was an Axon Epoch 2000 neurophysiological recording system (Axon Systems, Hauppauge, NY, USA). This monitor allows for simultaneous asynchronous stimulation and recording of both the MNSSEP and PTNSSEP. Standard parameters were used for both recording and stimulating the upper limb and lower limb SSEP. Subdermal needle electrodes (Rochester Electro-Medical Inc., Tampa, FL, USA) were inserted after the induction of anesthesia and used for both stimulating and recording. The electrode impedance was maintained below 5.0 k ohms and the inter-electrode impedance below 1.0 k ohms. The MNSSEP was stimulated at the wrist with a 250 µsec duration square wave pulse of 20 to 30 mA intensity, 3.1 pulses·sec⁻¹. The PTN was stimulated at the ankle (posterior to the medial malleolus) using the same stimulation parameters. Baseline recordings were acquired soon after the induction of anesthesia and subsequent, comparative recordings were obtained continuously during the procedure. The MNSSEP was recorded from the brachial plexus (Epi-Epc), the upper cervical spine (Cv2-Fpz), and the sensory cortex (CpC-Fpz). The PTNSSEP was recorded from the upper cervical spine (Cv2-Fpz), and the sensory cortex (CPz-Fpz, CPz-Cpi). A common ground electrode was placed on the patient’s sternum.

Patient demographic information was documented including the neurological history, reason for surgery and the immediate preoperative neurological status. SSEP data recorded included the measurements of the amplitude and latency of the cortical peaks (N20, P37) for baseline evoked potentials after induction of anesthesia and prior to cross clamping of the carotid artery. The incidence of any changes occurring during the procedure and especially after cross clamping of the carotid artery were documented. The incidence of shunting was documented. The patients were examined on emergence from anesthesia for any change in their neurological status and new postoperative neurological deficits were noted. The incidence, the timing, and the duration of all PTNSSEP changes were compared to MNSSEP changes. Chi-square testing was performed for statistical analysis of the raw data.

Results
All 153 patients who underwent a carotid endarterectomy were included in this study. The mean age ± SD was 68 ± 9 yr, weight 76 ± 14 kg, ASA III (median), range 2 to 4, and there were 54 female and 99 male patients. The indications for surgery included TIA (n = 91), stroke (n = 52) and asymptomatic carotid stenosis (n = 10). The degree of stenosis of the ipsi-