Practical use of near infrared spectroscopy and somatosensory evoked potential monitors in carotid endarterectomy surgery with routine shunting " A prospective study"

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BACKGROUND & OBJECTIVES: The major concern in carotid artery endarterectomy (CEA) procedure under general anesthesia (GA) is early detection of cerebral hypoperfusion during carotid cross clamping. Many studies have compared the prophylactic value of intraoperative neurologic monitors for detecting cerebral ischemia in patients undergoing CEA using selective shunting. We describe the practical application of near infrared spectroscopy (NIRS) and somatosensory evoked potentials (SEP) in patients undergoing CEA using routine shunting.

METHODS: 34 consecutive patients undergoing 40 CEA procedures with patch closure using routine shunting were included. Age ranged from 48 to 86 years. Standard anesthetic and monitoring techniques were used in all patients. Bilateral regional cerebral oxygen saturation (rSO2) was recorded continually before preoxygenation and continued until recovery from anesthesia, using cerebral oximeter (Somanetic INVOS5100 cerebral oximeter, COVIDIEN, USA)(Figure 1). An arterial line was placed for continuous blood pressure measurement before induction of GA. Mean arterial pressure was kept stable within a range of ±20% of the pre-operative level. SEP monitoring was performed from induction of to recovery from anesthesia (ISIS IOM Neuromonitoring, Inomed, GERMANY).The peak-to-peak amplitudes and latency of the primary ipsilateral cortical response N19/P22 complex were measured online. Any reproducible decrease of peak-to-peak amplitudes more than 50%, or increase of latency more than 10% vs the preclamping values, were documented as ischemic SEP change. After shunt insertion the surgical team was informed of any sudden ischemic change of ipsilateral rSO2 or SEP. All patients were extubated in the operation theater. At this point patients were tested for the development of any new neurological deficit.

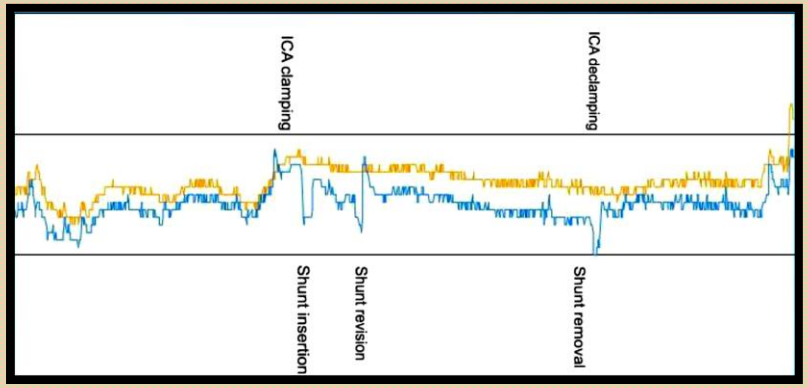

Figure 1: Course of bilateral regional cerebral oximetry in a 70-year old female patient admitted for right carotid artery endarterectomy using routine shunt placement. She had an asymptomatic 95% stenosis of right ICA with normal contralateral ICA and vertebral arteries. After ICA cross-clamping, a sudden decrease of ipsilateral rSO2 occurred that recovered immediately after shunt placement. During shunting a sudden drop of ipsilateral rSO2 occurred that was restored by shunt revision. Drop of rSO2 occurred also after shunt removal and immediately recovered after ICA declamping.There was no significant change of neither amplitude nor latency of SEP. No new neurological deficit was found at post-operative follow up period.

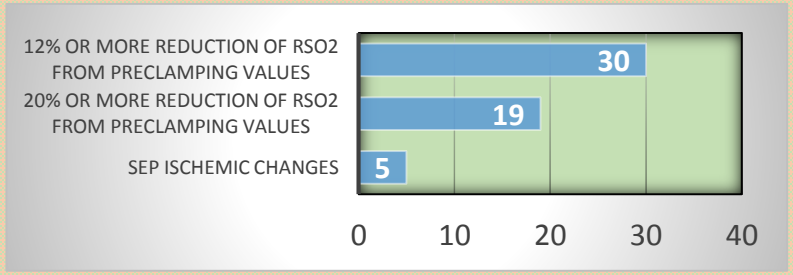

Figure 2: SEP and rSO2 changes after internal carotid clamping and before shunt insertion.

RESULTS: Reconstruction of ICA was successfully completed in all 40 surgeries. No patient developed permanent or transient new neurological deficit on the side of endarterectomy. The mean time between ICA cross-clamping and shunt insertion was 140±51 seconds, (range of 70 to 270 seconds). The mean shunting time was 36±9 minutes, (range of 22 to 60 minutes). Accepting 20% and 12% reduction from preclamping values as ischemic threshold, 19 patients (47%) and 30 patients (75%) respectively, started rSO2 ischemic changes after ICA cross-clamping. Five patients (12%), showed ischemic SEP change after ICA cross-clamping (Figure 2). rSO2 and SEP returned to pre-clamp value in all cases after shunt insertion (Figure 1). In 14 cases (35%) a sudden decrease in ipsilateral rSO2, prompted recheck of shunt function that after reposition and/or flushing the shunt, rSO2 returned to pre-malfunction values. In two of these patients SEP values changed significantly.

CONCLUSION: NIRS is based on the transmission and absorption of NIR light as it passes through tissue and is able to rapidly detect changes of the proportion of oxyhemoglobin and deoxyhemoglobin related to cerebrovascular perfusion changes. SEP is used to assess the functional status of somatosensory pathways during surgical procedures. With the beginning of cerebral hypoperfusion, changes of cerebrovascular O2 content precedes the functional changes of neural system. In term of early detection of cerebral ischemia in patients undergoing CEA procedures using routine shunting, NIRS seems to be more practical than SEP monitoring.