MONITORING CEREBRAL OXIMETRY BY INFRARED CEREBRAL SPECTROSCOPY (NIRS) IN CAROTID THROMBENDARTERECTOMY

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Abstract: *Cerebral hyperfusion after carotid artery clamping occurred during thrombendarterectomy (TEA) may bring about the occurrence of a new stroke or may aggravate the existing injuries caused by previous ischemic events, for which it is necessary to maintain adequate cerebral perfusion at a critical time of the surgical procedure.*

Cuvinte cheie: *hiperperfuzia cerebrală, arteră carotidă*

Rezumat: *Hiperperfuzia cerebrală survenită postclampare a arterei carotidei în timpul TEA, poate determina apariţia de noi AVC sau poate agrava leziunile deja existente cauzate de evenimentele ischemice anterioare, fapt pentru care se impune menţinerea unei perfuzii cerebrale adecvate într-un moment critic al procedurii chirurgicale.*

INTRODUCTION

Cerebral hyperfusion after carotid artery clamping occurred during thrombendarterectomy (TEA) may bring about the occurrence of a new stroke or may aggravate the existing injuries caused by previous ischemic events, for which it is necessary to maintain adequate cerebral perfusion at a critical time of the surgical procedure.(1,4,2,7) The use of the intraluminal shunt as a selective manoeuvre requires the use of a technique as a reliable monitoring indicator for an optimal interaoperative approach under general anaesthesia.(17)

By using cerebral oximetry by infrared spectroscopy (NIRS) in TEA, we can capture and define the critical threshold of the regional oxygen saturation (rSO2), in which neurological symptoms appear.(23,19,8)

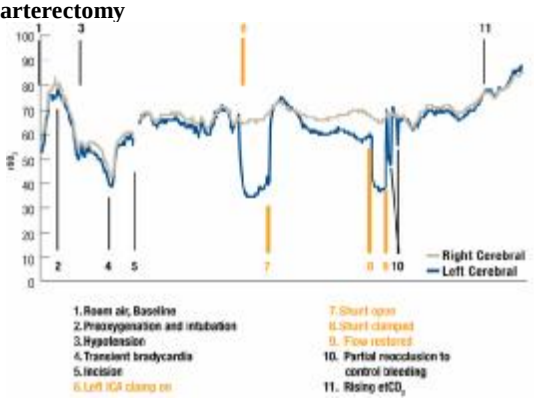
PURPOSE

The purpose of this retrospective study was to determine the percentage of the patients that reach a critical point of cerebral perfusion during TEA under general anaesthesia and to reliably identify the patients without cerebral imminent ischemia, with a view to use or not the intraluminal shunt.(21,6,10)

METHODS

We examined the rSO2 changes detected by cerebral oximetry (NIRS) in 89 TEA cases performed under general anaesthesia in the cardiovascular surgery clinic within the Emergency Clinical County Hospital of Constanţa, between 2008 and 2010. All those 89 patients had tight stenosis of the internal carotid artery (> 70%) and 38 also had contralateral internal carotid occlusion, detected by echo Doppler and by angiographic evaluation (angioCT, angio MRI) and by arteriography. All TEA procedures were performed under general anaesthesia and controlled hypertension (20% above arterial tension preoperative mean value) by using adrenaline and plasma intravascular expander. Routine monitoring included ECG, arterial hypertension monitoring, pulse oximetry, cerebral oximetry capnography, NIRS with INVOS 5100. Usually, we used heparin i.v. (5000 IU) before carotid clamping. rSO2 values were recorded every 20 seconds during carotid preclamping, carotid postclamping and postdeclamping. The duration of the carotid clamping was recorded for each patient. All patients were tested after extubation in order to detect a possible neurological deficit. The patients with neurological symptoms who gave up 24 hours later were considered as having transient ischemic attack (TIA) and those having a neurological deficit 24 hours later were considered stroke patients. The descriptive statistical analysis was calculated in terms of average and standard deviations (SD) for continuous variables and in terms of absolute and relative frequency of variables. The relative changes compared with the rSO2 initial values were calculated for the different groups of patients, with a less increase of 20% and with a safety margin of 95%.

Figure no. 1. Detection of cerebral ischemia during carotid endarterectomy



RESULTS

The basic characteristics of the 89 patients according to age, sex, location, contralateral occlusion and rSO2 average value are presented in Table no. 1. rSO2 mean values over time

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are presented in Table no. 2

Table no. 1. Characteristics of the basic values

Characteristics	N=89
Age in years (mean (SD))	5.96 (6.7%)
Male (N,%)	62.3 (70%)
Left carotid (N,%)	47.17 (53%)
Contralateral carotid occlusion	6.23 (7%)

Table no. 2. rSO2 values over time (N =89)

rSO2 measurement from the baseline	Mean (SD)	Change (95% CI)
Baseline	6,05 (6.8)	—
Early value	6,40 (7.2)	- 8.5
Mean crossclamp	6,14 (6.9)	- 7.9
Mean lowest crossclamp	6,40 (7.2)	-12.4
Mean post declamp	5,96 (6.7)	-

Neurological complications occurred in 3.4% of the cases. In cases of decreased rSO2 with 20%, they occurred within the first carotid postclamping 2 minutes. The specificity and sensitivity and the predictive values based on data prevalence were calculated in order to assess the ability of a critical reduction of rSO2, in order to predict shunting usefulness or in order to predict neurological complications. We observed a high rate of true negative cases, resulting in the high specificity of the negative value of less than 20% in identifying the patients with good cerebral perfusion through collateralization. The reduction of rSO2 with 20% had a lower sensitivity (30%) but a higher specificity (98%) to identify the patients with complications, with positive and negative predictive values of 37% and 98%. In the group of 89 patients, rSO2 decrease ranged from 44 and 0 (9 on average). The impact of a decrease of more than 20% is clinically relevant, involving neurological complications.

CONCLUSIONS

The relative change of rSO2 rather than the absolute number is a reliable indicator of ischemia threshold in order to determine the need for a shunt. The duration of the decrease of rSO2 is also an important factor in determining neurological effects.(1,7,15) It is not surprising that the reduction of cerebral oxygen saturation for a short period of time can be tolerated without permanent brain damages. In order to take the best decision regarding the use of the shunt, the surgeon must wait up to 2 minutes after carotid clamping (rSO2 time fluctuation due to self-regulation). NIRS is not affected by drugs as opposed to EEG and somatosensory evoked potentials (SSEP) that are low in amplitude by the drugs that depress brain metabolism during general anaesthesia.(1,4,3,6,9,11) NIRS provides continuous and real-time assessment of cerebral cortical oxygenation, by non-invasive means and it is a useful method for monitoring hypoperfusion in TEA.(1,4)

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