



STUDY OF THE EFFECT OF MONITORING INTRAOPERATIVE REGIONAL CEREBRAL OXYGEN SATURATION ON POSTOPERATIVE COGNITION IN ELDERLY PATIENTS UNDERGOING MAJOR ABDOMINAL SURGERY

Anaesthesiology

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ABSTRACT

Introduction: Cerebral oximetry estimates the oxygenation of regional tissue by transcutaneous measurement of the cerebral cortex, an area of the brain that is particularly susceptible to changes in the demand and supply of oxygen, and which has a limited oxygen reserve. Postoperative cognitive dysfunction is not uncommon in elderly patients after major surgery.²⁰ The studies using NIRS have shown that there was a significant relationship between low rSO₂ and neurologic complications, cognitive function, and prolonged hospitalization for the patients undergoing abdominal operation.

Aim & Objective: This prospective, randomized, single blind investigation was conducted to evaluate whether using rSO₂ monitoring in elderly patients undergoing major abdominal surgery reduces the potential exposure of the brain to inadequate oxygen supply and to evaluate the incidence of postoperative cognition dysfunction. **Material & Method:** Patients were divided into two groups: Group I (Intervention group, n= 63) and Group C (Control group, n=63). Regional cerebral oxygen saturation (rSO₂) was continuously monitored using near-infrared spectroscopy (INVOS Oximeter, 5100C). Sensors for cerebral oximetry were placed bilaterally on the right and left sides of the patients' forehead and rSO₂ data was continuously recorded. Cognitive function of the patients were assessed using the MMSE scoring the day before surgery and then were repeated at seventh postoperative day. **Conclusions:** This prospective randomized single blinded control study shows that, a total of 19.04% of elderly patients desaturated intra-operatively while undergoing major abdominal surgery. The patients who had desaturation, using rSO₂ monitoring, received management during anaesthesia, reducing potential exposure of the brain to hypoxia, resulted in less cognitive dysfunction in the post-operative period. In spite of giving all the measures, rSO₂ values could not be restored to the acceptable range in two patients.

KEYWORDS

Post-operative cognitive dysfunction (POCD) . Regional cerebral oxygen saturation (rSO₂), Mini-Mental State Examination (MMSE), near-infrared spectroscopy (NIRS).

INTRODUCTION:

Elderly patients are more prone to develop cerebral desaturation than younger patients due to decreased physiological reserve that accompanies aging and thus the incidence of postoperative cognitive dysfunction (POCD). Cerebral oximetry estimates the oxygenation of regional tissue by transcutaneous measurement of the cerebral cortex, an area of the brain that is particularly susceptible to changes in the demand and supply of oxygen, and which has a limited oxygen reserve. This prospective, randomized, single blind investigation was conducted to evaluate whether using rSO₂ monitoring in elderly patients undergoing major abdominal surgery reduces the potential exposure of the brain to inadequate oxygen supply and to evaluate the incidence of postoperative cognition dysfunction. The mini-mental state examination (MMSE) or Folstein test is a 30 point questionnaire that is used extensively in clinical and research settings to measure cognitive impairment.²³

OBJECTIVES:

General objectives-

To evaluate whether monitoring cerebral oxygen saturation (rSO₂) minimizes intra-operative cerebral desaturation and decreases the incidence of postoperative cognition dysfunction (POCD).

Specific objectives-

1. To monitor / record rSO₂ in pre-operative and per-operative period in both the groups.
2. To evaluate the MMSE score in pre-operative period and post-operative period (7 days After surgery)
3. To compare the rSO₂ in pre-operative and post-operative period in both the groups.
4. To compare the MMSE score in pre-operative and post-operative seventh day in both the groups.

MATERIALS AND METHODS:

Study tools- INVOS Oximeter, 5100C, Pulse oximeter, Multi Channel Monitor (Philips, Intelli Vue mp20), Anaesthesia Workstation (Spacelabs Healthcare), MMSE scoring scale.

Definition of problem-

To monitor rSO₂ by application of INVOS cerebral oximeter electrodes in both left and right side of forehead of patients.

Definition of population –

Total number of patients (126) of either sex, American Society of Anaesthesiologists (ASA) Physical Status (PS) I & II aged between 65-75 years were considered in this study who were undergo elective major abdominal surgery

• Study Variables:

- a) rSO₂ monitoring
- b) MMSE Score

Table No-1 MMSE Score

Category	Possible Points	Description
Orientation to time	5	From broadest to most narrow. Orientation to time has been correlated with future decline.
Orientation to place	5	From broadest to most narrow. This is sometimes narrowed down to streets, and sometimes to floor.
Registration	3	Repeating named prompts
Attention and calculation	5	Serial sevens, or spelling "world" backwards. It has been suggested that serial sevens may be more appropriate in a population where English is not the first language.
Recall	3	Registration recall
Language	2	Naming a pencil and a watch
Repetition	1	Speaking back a phrase
Complex Commands	6	Varies. Can involve drawing figure shown.

INCLUSION CRITERIA:

- a) Patients belonging to ASA PS I, II
- b) Adult patients of either sex aged between 65-75 years
- c) Patients scheduled for elective major abdominal surgeries such as
- d) Laparotomic gastric resection
- e) Laparotomic colonic resection
- f) Radical cystectomy
- g) Radical Nephrectomy

EXCLUSION CRITERIA:

- a) Patient refusal.
- b) Age <65yrs and >75yrs

- c) ASA physical status $\geq$ III and IV
- d) Patients with pre-existing cerebral pathology (such as previous episodes of cerebral ischemia or stroke)
- e) Base line Mini Mental State Examination (MMSE) test $\leq$ 23
- f) Patients whose follow-up was not probable (not expected to be discharged alive from the hospital or with an expected hospital stay $<$ 4 days) were excluded
- g) Bleeding or coagulation abnormalities
- h) Patients on antipsychotic drugs
- i) History of drug abuse.
- j) Any pre-existing neurological disorders.

Patients aged between 65-75 years of either sex of ASA PS I & II, scheduled for major abdominal surgery (laparotomic colonic resection, gastric resection, radical cystectomy, radical nephrectomy) were included in the study. Patients with pre-existing cerebral pathology (such as previous episodes of cerebral ischemia or stroke) and ASA physical status $\geq$ 3 and baseline Mini Mental State Examination (MMSE) test $\leq$ 23 and patients who were expected to be discharged within 4 days or not expected to be discharged alive from hospital were excluded.

Using a sealed envelope technique, patients were randomly allocated into two groups; in the control group (C) the screen of the INVOS monitor was blinded and general anaesthesia was managed routinely maintaining arterial blood pressure and heart rate values within 20% of baseline values. In the Intervention group (I) the screen of the INVOS monitor was visible and anaesthesia management was aimed to maintain rSO₂ more than 75% of baseline values. Cerebral desaturation is defined as a reduction of rSO₂ less than 75% of baseline (80% if the baseline value is $<$ 50%) for $\geq$ 15 seconds. In case of cerebral desaturation in the intervention group, a two step management protocol were activated: first step was to check the ventilator, head position, tubing system, increasing FiO₂, increase end-tidal CO₂ partial pressure if the EtCO₂ is $<$ 35 mm Hg and increasing arterial blood pressure with intravascular fluid administration (250 mL hetastarch) and vasoconstrictors (phenylephrine) if systolic blood pressure goes below $\leq$ 90 mm Hg. If the first step does not restore acceptable rSO₂ values within 60s, the second step was reduction of brain oxygen consumption with an iv bolus of propofol (0.5 mg/kg).

RESULTS AND ANALYSIS: One hundred and twenty six patients were randomly allocated into two groups as group C (Control group) and group I (Intervention group). In the control group (C) the screen of the INVOS monitor was blinded and general anaesthesia was managed routinely maintaining arterial blood pressure and heart rate values within 20% of baseline values. In the Intervention group (I) the screen of the INVOS monitor was visible and anaesthesia management was aimed to maintain rSO₂ more than 75% of baseline values. Cognitive function of the patients were assessed using the MMSE scoring the day before surgery and then were repeated at seventh postoperative day.

Table No-2 : Age

	Group	N	MEAN	Standard Deviation	P value
Age	CONTROL	63	66.92	1.763	0.659
	INTERVENTION	63	66.78	1.699	

Table No-3: Sex

	Group	Row%	P value
Male	Control	63.49	0.707
	intervention	68.25	
Female	Control	36.51	
	intervention	31.75	

Table no-3 shows mean sex distribution among two groups.

Table No:4 Episodes of Desaturation among the two groups

Group	Desaturation(No)	Desaturation(Yes)	Row Total
Control	52 (82.54%)	11 (17.46%)	63
Intervention	61 (96.83%)	2 (3.17%)	63
Total	113	13	126

Fisher's exact test 2-tailed p value 0.016

Table no.5- Episodes of cognitive Dysfunction among two groups-

Group	Cognitive Dysfunction(No)	Cognitive Dysfunction(Yes)	Row Totals
Control	57 (90.48%)	6 (9.52%)	63
Intervention	63 (100%)	0	63
Total	120	6	126

Table no-10: Episodes of Cognitive dysfunction in whole cohort Desaturation-

Group	Cognitive Dysfunction(no)	Cognitive Dysfunction(Yes)	Row Totals
Desaturation(No)	109 (96.46%)	4 (3.54%)	113
Desaturation(Yes)	11 (84.62%)	2 (15.38%)	13
Total	120	6	126

Table No 6- Episodes of cognitive dysfunction in control group Desaturation-

Group	Cognitive Dysfunction(no)	Cognitive Dysfunction (Yes)	Row Totals
Desaturation (No)	48 (92.31%)	4 (7.69%)	52
Desaturation (Yes)	9 (81.82%)	2 (18.18%)	11
Total	57	6	63

Table No-7: Cerebral Oxygen Saturation Derived Variables And Mini Mental State Examination Among Two Group Of Patients.

	GROUP	MEAN	P VALUE
rSO ₂ Avg_Min	CONTROL	42.33	0.000
	INTERVENTION	45.49	
rSO ₂ Avg_Fall	CONTROL	10.90	0.001
	INTERVENTION	8.51	
PercentFall rSO ₂	CONTROL	20.33	0.000
	INTERVENTION	15.60	
MMSE_Pre	CONTROL	27.22	0.293
	INTERVENTION	27.05	
MMSE_7d	CONTROL	26.83	0.887
	INTERVENTION	26.97	
MMSEFall	CONTROL	0.40	0.026
	INTERVENTION	0.08	

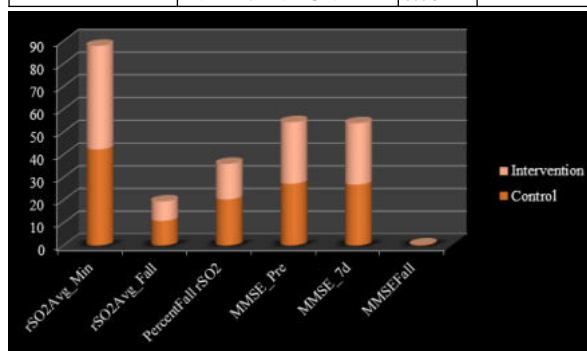
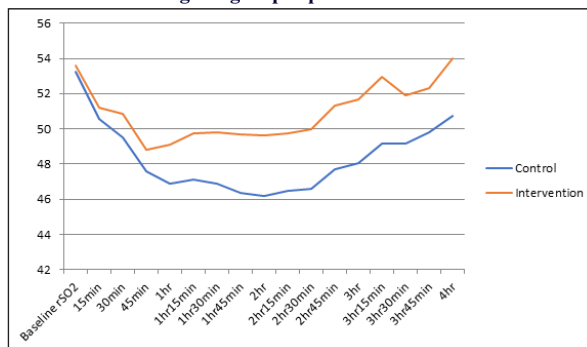


Figure1: Bar diagram showing relationship between rSO₂ and MMSE score among two group of patients.



The line diagram showing rSO₂ variation among two groups.

Figure 2: rSO₂

DISCUSSION

Cerebral oximetry estimates the oxygenation of regional tissue by transcutaneous measurement of the cerebral cortex, an area of the brain that is particularly susceptible to changes in the demand and supply of oxygen, and which has a limited oxygen reserve. Measurement is based on the ability of light to penetrate the skull and to determine haemoglobin oxygenation according to the amount of light absorbed by haemoglobin, a process called near-infrared spectroscopy (NIRS).¹¹ Monitoring is non-invasive and it can provide an early warning of decreased oxygen delivery.

The Mini-Mental State Examination (MMSE) or Folstein test is a 30 point questionnaire that is used extensively in clinical and research settings to measure cognitive impairment.²³

A MMSE can be considered before and after surgery for patients that are at risk for POCD [elderly, patients with baseline dementia or cognitive deficits, etc] in order to establish a baseline and monitor for the occurrence of POCD, respectively.²⁴

The present study was designed to assess the effect of monitoring Intraoperative Regional Cerebral Oxygen Saturation on Postoperative Cognition in elderly patients undergoing major abdominal surgery. Patients were divided into two groups: Group I (Intervention group, n= 63) and Group C (Control group, n=63).

In our study, rSO₂ monitored in 126 patients undergoing major abdominal surgery with general anaesthesia. Per-operative desaturation observed in 13 patients (20.63%) in intervention group and, in 11 patients (17.46%) in control group. In 11 of the 13 patients of the intervention group with intraoperative desaturation, rSO₂ recovered to acceptable values with only the first treatment step (increasing FiO₂, ET CO₂ partial pressure, and arterial blood pressure), 2 patients (3.17%) remain in desaturated state despite propofol treatment.

Casati A et al⁸ in 2005 monitored rSO₂ in 122 elderly patients undergoing major abdominal surgery with general anaesthesia. Cerebral desaturation (defined as an rSO₂ reduction 75% of baseline) was observed in 11 patients in the treatment group (20%) and 15 patients of the control group (23%). de Tournay-Jette E et al in 2011⁷⁵ in their study, they observed that the relationship between cerebral oxygen saturation changes and post-operative cognitive dysfunction in elderly patients after coronary artery bypass graft surgery. A total of 61 patients were allocated for CABG surgery where they observed forty-six patients (80.7%) developed early POCD, and 23 (38.3%) showed late POCD. Salazar F et al in 2014³² studied the relationship between intraoperative regional cerebral oxygen saturation trends and cognitive decline after total knee replacement in patients over 65yrs of the age (n=125) under spinal anaesthesia. They observed significant decrease in rso₂ in all patient during surgery. They concluded that detection of a trend to asymmetry in rSO₂ values can warn the physicians about the possible post-operative onset of memory decline

In our study we found mean pre-MMSE score 27.22 and 27.05 in control group and intervention group respectively. The mean MMSE score after 7th post-operative day were 26.83 and 26.97 in control and intervention group respectively. In our study, a decline in cognitive function during the first week after surgery was observed in 6 patients of the control group (9.52%). No cognitive dysfunction observed in intervention group. Casati A et al⁸ in 2005 monitored rSO₂ in 122 elderly patients undergoing major abdominal surgery with general anaesthesia. A decline in cognitive function (defined as a reduction in MMSE ≥ 2 points from baseline) during the first week after surgery was observed in 20 patients of the treatment group (35%) and 30 patients of the control group (54%) (P = 0.137). No differences in MMSE score were observed between groups throughout the study. Casati et al in 2005⁸. They monitored rSO₂ in 122 elderly patients undergoing major abdominal surgery with general anaesthesia. No differences in arterial blood pressure values (systolic and diastolic), heart rate, or peripheral oxygen saturation were reported between the two groups.

We also observed that cardiac complication occurs in 7 patients (5.56%) (P=1.00), respiratory complication in 14 patients (11.12%) (P=1.00) and surgical complication 10 patients (7.93%) (P=1.00) of the entire group in our study. There is no neurological complication in our study.

Summary:

Postoperative cognitive dysfunction is not uncommon in elderly patients after major surgery.⁷ Several studies have described early POCD whereas long term POCD is seldom found.⁸ The studies using NIRS have shown that there was a significant relationship between low rSO₂ and neurologic complications, cognitive function, and prolonged hospitalization for the patients undergoing abdominal operation or CABG surgery under anaesthesia. Using rSO₂ monitoring to manage anaesthesia in elderly patients undergoing major abdominal surgery reduces the potential exposure of the brain to hypoxia; this might be associated with decreased effects on cognitive function and shorter PACU and hospital stay.

The Mini-Mental State Examination (MMSE) or Folstein test is a 30 point questionnaire that is used extensively in clinical and research settings to measure cognitive impairment.¹⁷ It is commonly used in medicine and allied health to screen for dementia. It is also used to estimate the severity and progression of cognitive impairment and to follow the course of cognitive changes in an individual over time; thus making it an effective way to document an individual's response to treatment.

Result:

Both the groups were comparable in terms of age, sex, ASA grade and duration of surgery. No differences in arterial blood pressure values (systolic and diastolic), heart rate, or peripheral oxygen saturation were reported between the two groups. rSO₂ monitored in 126 patients undergoing major abdominal surgery with general anaesthesia. Per-operative desaturation observed in 13 patients (20.63%) in intervention group and, in 11 patients (17.46%) in control group. In 11 of the 13 patients of the intervention group with intraoperative desaturation, rSO₂ recovered to acceptable values with only the first treatment. In our study we found mean pre-MMSE score 27.22 and 27.05 in control group and intervention group respectively. The mean MMSE score after 7th post-operative day were 26.83 and 26.97 in control and intervention group respectively.

CONCLUSIONS:

This prospective randomized single blinded control study shows that, a total of 19.04% of elderly patients desaturated intra-operatively while undergoing major abdominal surgery. The patients who had desaturation, using rSO₂ monitoring, received management during anaesthesia, reducing potential exposure of the brain to hypoxia, resulted in less cognitive dysfunction in the post-operative period. In spite of giving all the measures, rSO₂ values could not be restore to the acceptable range in two patients.

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