Optimizing cerebral oxygenation in anaesthetized patients with carotid artery stenosis: the influence of inspired oxygen fraction

Editor—Carotid artery stenosis is a clear herald of poor neurological outcome and is associated with postoperative stroke, delirium, and lower regional cerebral oxygenation (rSO₂) as measured by near-infrared spectroscopy (NIRS). A decrease in rSO₂ of 10% from baseline or a decrease below an absolute value of 50% is associated with cerebral ischaemia. Increases in cerebral oxygenation have been demonstrated by increasing inspired oxygen fraction (FiO₂) in patients without vascular disease and during carotid endarterectomy (CEA). In our previous study, we analysed cerebral oximetry data obtained after the application of the carotid cross-clamp. Here we analysed previously unpublished data obtained before carotid cross-clamp placement in the same patient group to test the hypothesis that increasing FiO₂ results in a significant improvement in cerebral oxygenation for anaesthetized patients with carotid artery stenosis.

After approval by the Institutional Review Board of the University of Michigan, Ann Arbor, written informed consent was obtained from patients presenting for CEA on the day of surgery. Cerebral oxygenation was measured using the INVOS 5100B monitor (formerly Somanetics Corporation, Troy, MI, USA). Patients received a standardized i.v. induction and maintenance of inhaled anaesthesia as previously described. Phenylephrine (200 μg ml⁻¹) was titrated by infusion to maintain a stable arterial pressure between 100 and 125% baseline.

After tracheal intubation and patient positioning, FiO₂ was adjusted first at 100%, then 30%. End-tidal carbon dioxide (PfCO₂) was held in the range 5.3–6.0 kPa. After ≥5 min at each FiO₂, rSO₂ was recorded as a ‘snap-shot’ at the time of arterial blood gas analysis. A mean value for rSO₂ from both sides was calculated. A related sample Wilcoxon signed-rank test was used to evaluate the change in rSO₂, with each patient acting as their own control. P-values of <0.05 were considered statistically significant.

To standardize the assessment of the degree of carotid artery stenosis, we excluded two patients recruited for our original study who did not have their abnormality demonstrated with carotid Doppler ultrasonography performed at our institution. Analysis was completed for the remaining 18 patients. The average baseline rSO₂, measured with patients awake breathing room air, varied between 36% and 71%. There was no significant difference between rSO₂ measured on operative and non-operative sides at baseline or at either study point. One patient received N₂O. Seventeen patients required phenylephrine by infusion. rSO₂ was 8% higher when 100% O₂ was delivered compared with 30% (median 69, IQR 58–82 vs median 61, IQR 57–72, P≤0.001) (Fig. 1). Intended increments in the partial pressure of oxygen in arterial blood were statistically significant (52.5
kPa, SD 12 vs 15.7 kPa, SD 4.8, P ≤ 0.001). There were no statistically significant differences in heart rate, arterial pressure, anaesthetic vapour concentration, haematocrit, phenylephrine dosing, or the partial pressure of carbon dioxide in arterial blood between the measurement points.

The results of the study demonstrate that cerebral oxygenation varies directly with \( F_{\text{IO}_2} \) in anaesthetized patients with severe carotid artery stenosis. The observed increase in \( rSO_2 \) was similar to that reported in anaesthetized ventilated patients without vascular disease\(^6\) and in anaesthetized patients\(^5\) after the placement of a carotid cross-clamp. Contrary to previous reports,\(^2\) we did not observe a relationship in the degree of carotid artery stenosis and \( rSO_2 \) between hemispheres. Recent evidence suggests that bolus-dose phenylephrine is associated with a measureable decrease in \( rSO_2 \) of 7–8 min duration.\(^6\) Here there was no difference in phenylephrine dosing between the groups. The effect of phenylephrine by infusion has yet to be investigated. Although the clinical significance of an 8% increase in \( rSO_2 \) remains to be determined, the results provide a rationale to increase \( F_{\text{IO}_2} \) in ventilated patients with severe carotid artery disease and illustrate that measurement of cerebral oxygenation by NIRS may be helpful for such patients undergoing non-vascular surgical procedures. Increasing \( F_{\text{IO}_2} \) may be especially helpful during periods of increased neurological risk such as hypotension and anaemia or if surgical positioning is likely to impede cerebral blood flow. The adverse consequences of ventilating patients with 100% \( O_2 \) for relatively short periods are likely to be limited.

**Declaration of interest**

The INVOS 5100B cerebral oxygenation monitor and cerebral oxygenation optodes were provided at no cost by the manufacturer (formerly Somanetics Corporation, Troy, MI, USA).

---

**Combined technique using videolaryngoscopy and Bonfils for a difficult airway intubation**

Editor—A difficult tracheal intubation can sometimes still be a problem, even if one has taken all precautions such as the evaluation of premetrics of a difficult airway, difficult airway trolley, and help from additional qualified personnel. The BURP manoeuvre\(^1\) is usually the first technique applied when laryngoscopy reveals a Cormack and Lehane grade III or IV, followed by the use of a number of adjuncts (gum elastic bougie, stylet) or different approaches of the airway (e.g. fibreoptic intubation, supraglottic airway, videolaryngoscopy). Nevertheless, even when all the above techniques have been applied properly, tracheal intubation still can be very challenging in the rare event that no part of the glottic entrance, nor the epiglottis can be seen.

We report our experience with a 45-yr-old woman (165 cm, 128 kg, BMI 48 kg m\(^{-2}\), ASA class II, Mallampati grade IV, thyromental distance 51 mm, mouth opening 41 mm, short restricted neck) who presented for bariatric surgery (sleeve resection) under general anaesthesia. She had a past medical history of hypertension and diabetes mellitus and during a previous operation for removal of the right ovary (in another hospital), she had a prolonged and very difficult intubation, which eventually was successful using the LMA-Fastrach\(^9\) as a conduit for tracheal intubation.

---


\( P \) 10.1093/bja/aer466

---

**Fig 1** Change in regional cerebral oxygenation (\( rSO_2 \)) from baseline. Median with inter-quartile range.