Isocapnic hyperventilation provides early extubation after sevoflurane anaesthesia for major ENT surgery: a clinical feasibility study

Katarina Hallén, Pether Jildenstål, Ola Stenqvist, Sven-Erik Ricksten, Sophie Lindgren
Dept of Anaesthesiology and Intensive Care Medicine, Institute of Clinical Sciences, The Sahlgrenska Academy,
Gothenburg University, Sweden. Email: katarina.hallen@vgregion.se

BACKGROUND

Isocapnic hyperventilation (IHV) is a method that shortens time to extubation after inhalation anaesthesia by increasing airway CO₂ during hyperventilation (HV).(1,2) In a pilot study on patients undergoing long-duration sevoflurane anaesthesia for major ear-nose-throat (ENT) surgery, we evaluated the feasibility of an alternative technique of IHV. (3,4)

METHODS

Fifteen adult patients weighing 76±12 kg were included. After end of surgery mechanical HV was started and CO₂ delivered (DCO₂) to the inspiratory limb of a closed standard breathing circuit. (Figure 1) DCO₂ was dosed according to gender and weight, based on previous experimental studies.(3,4) Time to extubation and eye-opening was recorded. Inspired (FICO₂) and expired (FETCO₂) CO₂ and arterial CO₂ levels were monitored during IHV. (Figure 2) Cognition was tested preoperatively and at 20, 40 and 60 min after arrival in the PACU.

RESULTS

A DCO₂ of 285±45 ml/min was necessary to achieve isocapnia during HV. The corresponding FICO₂-level was 3.0±0.3%. Time from turning off the vaporizer (1.3±0.1 MAC) to extubation (0.2±0.1 MAC) was 11.3±1.8 min (range 8-14 min) after 342±131 min (range 206-676 min) of anaesthesia. PaCO₂ and FETCO₂, remained at normal levels during and after IHV. In 85% of patients postoperative cognition returned to preoperative values within 60 minutes. (Table 1, 2)

References: (1) Sasano et al A Simple Apparatus for Accelerating Recovery from Inhaled Volatile Anesthetics Anesth Analg 2001; 93:1188-91. (2) Katznelson et al Isocapnic Hyperpnoea Shortens Postanesthetic Care Unit Stay After Isoflurane Anesthesia Anesth Analg 2010; 111:403-8. (3) Hallen K et al. A simple method for isocapnic hyperventilation evaluated in a lung model. Acta anaesthesiologica Scandinavica 2016; 60: 597-606.(4) Hallen K et al Isocapnic hyperventilation shortens washout time for sevoflurane - an experimental in vivo study. Acta anaesthesiologica Scandinavica 2016; 60: 1261-9. (4)

CONCLUSION

- The patients were safely extubated shortly after discontinuing long-term sevoflurane anaesthesia.
- Perioperatively, we did not find any adverse effects on arterial blood gases or postoperative cognition.
- Use of standard anaesthesia monitoring is sufficient for easy administration of CO₂ during hyperventilation and
- FICO₂ and FETCO₂ values can be used to fine tune DCO₂ during isocapnic hyperventilation
- This alternative method for IHV can potentially be used to decrease emergence time from inhalation anaesthesia.

Figure 1

Figure 2

Table 1. Time intervals from end of sevoflurane administration to extubation, eye-opening and discharge from the operating room in a feasibility study of an alternative method for isocapnic hyperventilation after major ENT surgery. N=15, Mean ± SD

Time to extubation (min)	11 ± 2
Time to open eyes (min)	13 ± 4
Time to discharge from operation (min)	21 ± 4

Table 2. Postoperative physiological, pain and recovery variables at arrival and 20, 40 and 60 min after arrival in the post anaesthesia care unit (PACU).

	At arrival in PACU	T ₂₀ min	T ₄₀ min	T ₆₀ min
Gas exchange				
ETCO ₂ (%)	5.0 ± 0.8	4.9 ± 0.9	5.1 ± 0.5	4.9 ± 0.7
PaCO ₂ (kPa)	5.5 ± 0.6	5.3 ± 0.7	5.8 ± 1.7	5.2 ± 0.4
SaO ₂ (%)	97 ± 2	97 ± 1	97 ± 1	97 ± 3
PaO ₂ (kPa)	13.3 ± 3.1	15.0 ± 3.1	14.9 ± 4.4	14.8 ± 3.0
P/F ratio	44 ± 17	51 ± 12	53 ± 18	52 ± 14
PONV and nociception (% of patients)				
Nausea and vomiting 0	80	80	80	80
PQRS N1 (Pain)	NA	80	86	86
PQRS N2 (PONV)	NA	80	80	80
Cognition (% of patients recovered)				
Sedation score 0-1	53	100	93	100
PQRS C1-5	NA	31	77	85

N = 15, Mean ± SD, ETCO₂ = End-tidal CO₂; PaCO₂ = Arterial CO₂ tension; SaO₂ = oxygen saturation; PaO₂ = arterial oxygen tension; P/F ratio = (PaO₂/FiO₂) x 100; Nausea and vomiting score 0 = none, 1 = nausea, 2 = nausea and vomiting; PQRS = Postoperative Quality of Recovery Scale; Sedation score 0 = fully awake, 1 = verbal response to command, 2 = eye opening on command; NA = Not Applicable