

Minimal flow anaesthesia for short elective day case surgery; high vaporiser settings are needed but still cost-effective

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Abstract

Aim: This is an observational study conducted in conjunction to the introduction of minimal fresh gas flow at our department. Data around the time to reach 1.2 % end-tidal sevoflurane, vaporiser setting to maintain this Et sevoflurane concentration and sevoflurane consumption at fresh gas flows; 1.0, 0.7, 0.5 and 0.3 L/min during elective day case anaesthesia in spontaneous breathing patients was compiled.

Data from forty ASA I-2 patients were collected. End tidal sevoflurane concentration of 1.2 vol. % can be reached within 4 minutes when minimal flow anaesthesia is used. Dialed concentrations must however be kept about 2 to 4 times aimed Etsevo concentration still lower amount of sevoflurane is consumed.

Keywords: Day case anaesthesia; Drug; sevoflurane, Low fresh gas flow, cost-effective.

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Fresh gas composition and flow rate have major influence on the consumption of inhaled anaesthetics. Reducing fresh gas flow has many potential advantages. We have in previous studies evaluated the effect of the composition of the fresh gas flow in day case anaesthesia. The impact on nitrous oxide on the sevoflurane consumption was shown repeatedly, reducing the sevoflurane consumption also when compared to a 1 L/min fresh gas flow [1, 2]. Also the independent effect of reducing the overall fresh gas flow was part of the evaluation in 2 studies, showing reduced sevoflurane consumption with lower flow rates [2, 3].

This is a presentation of data derived during implementation of minimal flow anaesthesia at our department. Time to reached a 1.2% end-tidal sevoflurane concentration, dialed sevoflurane vaporizer settings to maintain 1.2 end tidal concentration during surgery and sevoflurane consumption was compiled.

Methods

Data from forty ASA I-2 patients scheduled for elective foot surgery under general anaesthesia during the stepwise implementation of minimal flow, 0.3 L/min was compiled. All patients followed the routines of the department; fasting routines, preoperative information was all in accordance to the standard protocol.

All patients had betamethasone 8 mg intravenous after establishing an intra-venous line and an intravenous induction with propofol and low dose alfentanil. Local anaesthesia in the surgical area and or a peripheral block with lidocaine 10 mg/ml was applied prior to incision and bupivacaine at wound closure in all patients accordance to routines.

Patients were pre-oxygenated with FiO_2 1.0 with 3 L/min by facemask for at least 2 minutes for nitrogen wash-out before induction. After induction a laryngeal mask airway was placed and fresh gas flow set at 1 L./min oxygen. The vaporiser was set at 8

% and the fresh gas was kept at 1 L./min for 1 minutes. After the initial minute fresh gas flow was adjusted, reduced from our previous practice 1 L/min. To 0.7 L/min, 0.5 L/min and last a minimal flow of 0.3 L/min oxygen. Ventilation was assisted after induction when needed but patients were breath spontaneous as soon as possible. The dial vaporiser setting was adjusted in order to achieve an end-tidal sevoflurane concentration of 1.2 vol. %. The end-tidal concentration was kept at 1.2 % sevoflurane throughout the procedure. At wound closure the vaporiser was turned off and removed for weighing. The vaporiser was weighted prior to and after each procedure on a precise scale.

All patients were monitored in accordance with routines: pulse-oximetry; heart rate and oxygen saturation, non-invasive blood pressure. Respiration and gases was monitored with a main-stream multi gas monitor (VEO Multigas Monitor AX+ PHASEIN AB Svärdvägen 15, 182 33 Danderyd, Sweden)

Statistics

These are observational data compiled in conjunction with the implementation of reduced fresh gas flow at our department. All values are given as mean and standard deviation. Differences between groups are analysed by ANOVA, a $p < 0.05$ was considered statistical significant. All data and analysis were done on a Macintosh computer with StatView TM SE (Abacus Concepts Inc., Berkeley, CA, USA) software.

Results

The groups did not differ with regard to patient demographics or duration of anaesthesia see Table 1. All surgery and anaesthesia was uneventful and all patients were discharged in accordance to routines within 120 minute after end of anaesthesia.

Mean time to reach Et_{sevo} 1.2 increased with the reduction in the fresh gas flow but it was reached with 4 minutes in all patients (Table 1).

Table 1 Patients' characteristics and main findings.

	FG 0.3 L/min (n=10)	FG 0.5 L/min (n=10)	FG 0.7 L/min (n=10)	FG 1.0 L/min (n=10)
Age (years)	53 ± 10	46 ± 10	46 ± 10	45 ± 9
Weight (kg)	77 ± 9	73 ± 13	72 ± 16	70 ± 15
Sex female/male	6/4	6/4	7/3	5/5
Duration of anaesthesia (min.)	20 ± 8	20 ± 9	19 ± 5	22 ± 9
Time to Reached 1.2 % Et _{sevo} (min.)	3.6 ± .7	2.5 ± .5	1.5 ± .7	1.8 ± .4
Et _{sevo} /Fi _{sevo}	0.7 ± .1	0.7 ± .1	0.7 ± .1	0.7 ± .1
Dialed vaporiser setting/ Et _{sevo}	3.1 ± .5	2.6 ± .3	2.2 ± .5	1.6 ± .1

Et_{sevo} – end-tidal sevoflurane concentration Fi_{sevo} – inspired sevoflurane concentration.

The mean required dialed sevoflurane vaporiser settings increased each step of reduced flow rates (Table 2) and the mean sevoflurane consumption decreased (Table 3). No influence of sex was found (Tables 2 and 3).

Table 2 Dialed vaporiser sevoflurane setting in order to maintain an Et_{sevo} 1.2%.

	Female (n=24)	Male (n=16)	Total (n=40)
FG 0.3 L/min (n=10)	3.8	3.6	3.7
FG 0.5 L/min (n=10)	3.0	3.2	3.1
FG 0.7 L/min (n=10)	2.2	2.4	2.2
FG 1.0 L/min (n=10)	1.9	1.9	1.9
Totals	2.7	2.8	2.9

Table 3 The effects of fresh gas flow and sex on sevoflurane consumed, change in vaporiser weight before and after surgery gr./min.

	Female (n=24)	Male (n=16)	Total (n=40)
FG 0.3 L/min (n=10)	.17	.17	.17
FG 0.5 L/min (n=10)	.22	.22	.22
FG 0.7 L/min (n=10)	.23	.24	.23
FG 1.0 L/min (n=10)	.26	.26	.26
Totals	.22	.22	.22

Discussion

We found fresh gas early institution of minimal flow seemingly efficacious and safe to use during minor routine elective day case anaesthesia in patients breathing spontaneous on a laryngeal mask airway. Our results must of course be put into the perspective of the limited number of patients studied and the fact that all patients were health ASA 1-2 patients undergoing elective short outpatient procedures.

Cost-effective and safe anaesthetic techniques are sought. Inhaled

anaesthesia is commonly associated to lower cost that intra-venous techniques. We found in previous studies both sevoflurane and desflurane anaesthesia associated to lower cost compared to intra-venous techniques in minor day case anaesthesia [4, 5]. Also Smith et al found sevoflurane based anaesthesia cost effective; lower drug cost and no difference in emergence or time to discharge compared to propofol based anaesthesia [6]. In clinical routine anaesthetic technique, inhaled or intravenous, has not any major influence on recovery or patients' overall satisfaction [7].

We studied only a 1.2 % end tidal sevoflurane concentration. It should be acknowledged that all patients studied followed the routine multimodal pain management program. All patients had a peripheral block and or local anaesthesia infiltration at the surgical site prior to incision and alfentanil propofol co-induction. They also in accordance to the routines at our department had bupivacaine at wound closure and oral paracetamol and NSAIDs right at arrival in the recovery area. Multimodal analgesia and minimising the opioid use facilitates recovery and is associated to low risk for PONV [8, 9].

We used fresh gas of oxygen only. We did not systematically register inspired oxygen fraction. In low to minimal flow setting the oxygen fraction will decrease and needs to be closely monitored. The potential benefit of a slightly elevated oxygen fraction on postoperative nausea has been questioned. In the review by Rincón and Valero an effect on vomiting was seen and they concluded: *supplemental oxygen reduces the incidence of postoperative vomiting. Administration of supplemental oxygen could be an effective method of reducing postoperative vomiting* [10]. Orhan-Sungur et al could however not document any significant beneficial effect still no negative effects of higher FiO₂ have been seen in the studies evaluated [11].

Our results are in line with a recent French study looking at low flow anaesthesia in a circle system. They conclude "over dosage of dialed setting" is the fastest, reproducible and cheapest strategy to achieve (or to increase) a chosen end-tidal concentration [12]. We used one circle system with CO₂ absorber with the same volume for all patients studied. Dosch et al recently showed that, other than fresh gas flow rate, breathing system volume has the biggest effect on time to equilibrium when the composition of the fresh gas inflow is changed [13]. The risk for formation of toxic metabolites in the carbon dioxide absorbents associated to the administration of sevoflurane with low fresh gas flow has been debated. Recent studies with modern absorbents has however shown reassuringly low such formation [14].

The cost implications of lowering the fresh gas flow may not be seen

as important taking the the very small amounts of liquid sevoflurane consumed per each case into account. The effects should however be put into the perspective of the annual number of anaesthetic time. It should also be acknowledged that although the halogenated inhaled anaesthetics cause major environmental effects the less amount of halogenated carbon skeleton released into the atmosphere the better [15].

Conclusion

We found lowering the fresh gas flow to 0.3 litre per minute seemingly effective and safe and reduces the sevoflurane consumption during minor routine elective day case anaesthesia in ASA 1-2 patients breathing spontaneously on a laryngeal mask airway vaporiser settings must however be kept 2–4 times aimed end-tidal sevoflurane concentration. This is merely pilot data but we believe that minimising the fresh gas flow is a rational strategy and should be considered for routine use. Further studies are however warranted.

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