

Incidence of postoperative nausea and vomiting after paediatric strabismus surgery with sevoflurane or remifentanyl–sevoflurane

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Background. In this prospective, randomized, double-blind study, we evaluated and compared the incidence of postoperative nausea and vomiting (PONV) after paediatric strabismus surgery with two different anaesthetic methods, sevoflurane or remifentanyl–sevoflurane.

Methods. In total, 78 paediatric patients (aged 6–11 yr) undergoing strabismus surgery were enrolled and randomly assigned to two groups, sevoflurane (Group S) and remifentanyl–sevoflurane (Group R). Anaesthesia was maintained with 2–3% sevoflurane in Group S ($n=39$) or with a continuous infusion of remifentanyl combined with 1% sevoflurane in Group R ($n=39$), both using 50% N_2O/O_2 . Arterial pressure and heart rate before induction, after tracheal intubation, after skin incision, and at the end of surgery were recorded. The incidence of PONV in the post-anaesthesia care unit, the day surgery care unit, and at home 24 h after surgery was recorded.

Results. Arterial pressure and heart rate were stable throughout the surgery, but were significantly lower in Group R than in Group S after tracheal intubation and skin incision. The incidence of PONV and postoperative vomiting was 17.9%/17.9% and 12.8%/10.2% (Group S/Group R) at the respective time points; values were comparable between the groups.

Conclusions. The incidence of PONV after paediatric strabismus surgery under sevoflurane anaesthesia was relatively low, and combining remifentanyl with sevoflurane did not further increase the incidence.

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Postoperative nausea and vomiting (PONV) is a major concern in paediatric outpatient surgery and may increase patient discomfort, delay patient discharge, and increase the cost of patient care. The incidence of PONV after strabismus surgery is relatively high, compared with other outpatient surgeries, particularly in children. The majority of studies examining PONV after strabismus surgery used halothane as the main anaesthetic agent.^{1–4} Sevoflurane has been used safely during paediatric strabismus surgery, with a relatively low incidence of oculocardiac reflex, compared with halothane or propofol.^{5–7} However, few studies have investigated PONV after paediatric strabismus surgery with sevoflurane.^{8,9} Some studies comparing paediatric outpatient surgery with sevoflurane and halothane have shown that the incidence of PONV is significantly lower with sevoflurane than with halothane.^{10–12}

Remifentanyl is of high potency and rapid clearance and lacks accumulation-related problems. It is becoming more popular for short procedures in children and several successful uses in paediatric strabismus surgery have been reported.^{9,13} However, the effect of remifentanyl on the incidence of PONV is unclear.

The aim of the present study was to evaluate and compare the incidence of PONV after paediatric strabismus surgery under sevoflurane or combined remifentanyl–sevoflurane anaesthesia.

Methods

After obtaining institutional review board approval and written informed parental consent, 78 ASA class I

paediatric patients, aged 6–11 yr, undergoing elective strabismus surgery were enrolled. Before operation, patients were instructed to report if they felt nauseated at any time after the operation and parents were told that they would be asked via telephone about their children's PONV the day after surgery. All children fasted for at least 8 h before surgery (clear fluids were allowed until 2 h before anaesthetic induction).

Patients were randomly assigned to have anaesthesia maintained with sevoflurane (Group S) or sevoflurane plus remifentanyl (Group R). Patients were not premedicated, and anaesthesia was induced with i.v. propofol (2.5 mg kg^{-1}) premixed with 10:1 1% lidocaine during preoxygenation with 100% O_2 via a facial mask. After confirming loss of consciousness, assisted ventilation was started with 8% sevoflurane in Group S and with 1% sevoflurane in Group R, both in 50% N_2O . In Group R, continuous i.v. infusion of remifentanyl was started with $1 \text{ } \mu\text{g kg}^{-1}$ over 60 s and then maintained at $0.5 \text{ } \mu\text{g kg}^{-1} \text{ min}^{-1}$. Rocuronium (0.4 mg kg^{-1}) was injected immediately after the start of assisted ventilation, and the trachea was intubated after confirming neuromuscular block with a nerve stimulator. Monitoring included ECG, non-invasive arterial pressure, peripheral O_2 saturation, temperature, end-tidal CO_2 , and end-tidal sevoflurane [Capnomac, Ultima (tm); Datex-Engstrom Division, Helsinki, Finland]. The lungs were mechanically ventilated and ventilation was adjusted to achieve an end-tidal carbon dioxide concentration of 4.7–5.3 kPa. A fresh gas flow of 3 litre min^{-1} was used in a circle system [Aestiva 5 (tm); Datex-Ohmeda, Madison, WI, USA]. After intubation, the sevoflurane concentration was decreased to 2–3% in Group S and the remifentanyl dose was adjusted to $0.25 \text{ } \mu\text{g kg}^{-1} \text{ min}^{-1}$ in Group R. Intraoperatively, lactated Ringer's solution was given i.v. at $10 \text{ ml kg}^{-1} \text{ h}^{-1}$. Arterial pressure and heart rate were maintained within 20% of preoperative values and the sevoflurane concentration in Group S and the remifentanyl dose in Group R were adjusted as needed. Systolic arterial pressure and heart rate were recorded after arrival in the operating theatre, before induction of anaesthesia, after tracheal intubation, after skin incision, and at the end of surgery immediately after the cessation of anaesthetics.

After reversal with neostigmine (0.02 mg kg^{-1}) and glycopyrrolate (0.01 mg kg^{-1}), all patients were extubated in the operating theatre and transferred to the post-anaesthesia care unit (PACU). PONV was checked in PACU and in the day surgery care unit by anaesthetic nurses who were blinded to patient group. In addition to observing patients' retching, they were instructed to ask patients at least twice if they felt nauseated, that is, 'Do you feel like vomiting or a sensation like motion sickness?' PONV was also evaluated after discharge by another staff member blinded to patient group in a telephone call with the subjects' parents 24 h after surgery. Evaluation of the incidence and severity of vomiting was

done using a numeric rank score (0, no nausea or vomiting; 1, nausea but no vomiting; 2, vomiting once or twice; 3, vomiting on more than two occasions). Children with severe vomiting (score 3) received ondansetron (0.1 mg kg^{-1} ; maximum, 4 mg) i.v. as a rescue antiemetic. Fluid intake was allowed starting 6 h after operation. The type of surgery and the numbers of muscles operated on were recorded.

Statistical analyses

On the basis of 20% incidence of PONV in Group S observed in a pilot study, using previously described methods,¹⁴ the sample size to test for equivalence was 33 patients per group with $\alpha=0.20$, $\beta=0.05$, and an effect size 0.25. A Z-test was performed as described¹⁴ to prove the lack of difference between the two groups (the null hypothesis of $p_1-p_2>0.25$) with a one-sided *P*-value. Data are expressed as median (range), mean (SD), and number (% incidence). Patient characteristics and other clinical data were compared using the Student's *t*-test, the χ^2 test, and Fischer's exact test, as appropriate. All *P*-values were two-sided and were deemed to indicate statistical significance at $P<0.05$.

Results

Patient characteristics, such as gender, age, body weight, height, duration of surgery or anaesthesia, time to extubation from the cessation of anaesthetics, PACU stay time, day surgery care unit stay time, type of surgery, and the number of muscles operated on, showed no difference between groups (Table 1). Mean systolic arterial pressure and heart rate immediately after intubation and incision were significantly lower in Group R than in Group S, but were both within normal ranges (Fig. 1).

The incidence of PONV in the 24 h after surgery was not different between the two groups (17.9% vs 17.9%).

Table 1 Patient characteristics and clinical data. Data are expressed as median (range), mean (SD), or number (%). No significant difference was found between the groups

	Group S (n=39)	Group R (n=39)
Age (yr)	8 (6–11)	7 (6–11)
Gender (M:F)	18:21	22:17
Body weight (kg)	31 (11)	29 (9)
Body height (cm)	129 (22)	130 (12)
Duration of surgery (min)	14.8 (5.4)	15.7 (6.4)
Duration of anaesthesia (min)	28.9 (7.7)	31.2 (7.5)
Time to extubation (min)	7.3 (3.3)	8.5 (3.8)
PACU stay time (min)	21.4 (8.1)	20.6 (6.0)
Day surgery care unit stay time (min)	177.7 (63.1)	177.5 (58.2)
Type of surgery		
Recession	25	22
Resection	14	17
Number of muscles operated		
1	22	21
2	17	18

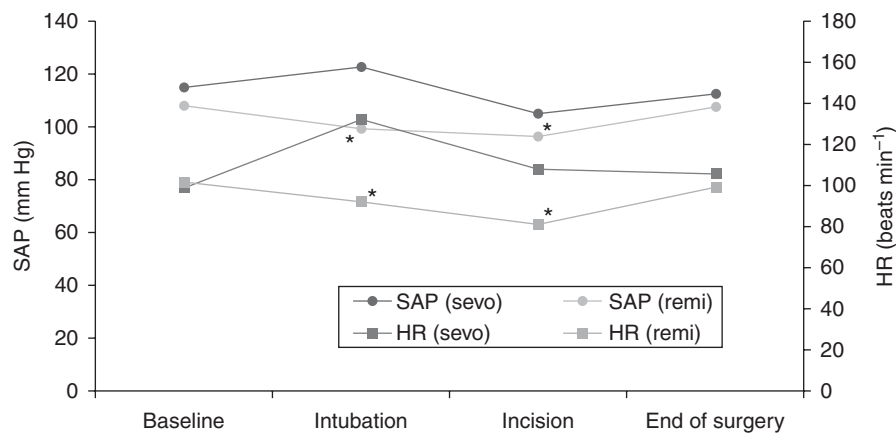


Fig 1 Changes in systolic arterial pressure and heart rate before and during the operation. SAP, systolic arterial pressure; HR, heart rate. Baseline, after arrival in the operating theatre, but before induction of anaesthesia. * $P < 0.05$ compared with Group S.

Table 2 Incidence of postoperative nausea and vomiting. Data are expressed as the number of patients (% incidence). PONV, postoperative nausea and vomiting; PACU, post-anaesthesia care unit. No significant difference was found between groups

	Group S (n=39)	Group R (n=39)
PONV	7 (17.1)	7 (17.1)
PACU	1 (2.5)	0 (0)
Day surgery care unit	2 (5.1)	3 (7.7)
Home	4 (10.2)	7 (17.1)

Table 3 Severity of postoperative nausea and vomiting. Data are expressed as the number of patients (% incidence). PONV, postoperative nausea and vomiting. No significant difference was found between groups

	Group S (n=39)	Group R (n=39)
No PONV	32 (82.1)	32 (82.1)
Nausea	2 (5.1)	3 (7.7)
Vomiting (1–2 times)	3 (7.7)	3 (7.7)
Severe vomiting (>2 times)	2 (5.1)	1 (2.5)

The null hypothesis that the incidence of PONV would be different between the two groups was rejected, with a P -value of 0.002. In the patients with PONV, only one patient had PONV in PACU (1 of 39, 2.5%), five patients had PONV in the day surgery care unit (5 of 39, 12.8%), and 11 patients had PONV at home (11 of 39, 28.2%; Table 2). The incidence of postoperative vomiting (POV), 12.8% (5 of 39) in Group S and 10.2% (4 of 39) in Group R, was also comparable. Two patients in Group S and one patient in Group R had severe vomiting at home, so no patients needed antiemetic treatment during their stay at the hospital (Table 3).

Discussion

The reported incidence of POV in children is estimated to be between 8.9% and 42%, approximately twice the incidence for both nausea and vomiting after surgery in

adults.^{15–17} POV rather than PONV is generally used in children as it is difficult to estimate the true incidence of nausea in young children, who may not be able to adequately express their level of discomfort associated with this subjective feeling. To address this, subjects were instructed before operation regarding nausea and were actively questioned twice. Younger children (<6 yr) were excluded from the study.

Strabismus surgery is reported to be a particularly emetogenic surgical procedure, with an emesis incidence ranging from 37% to 80%, without prophylactic antiemetic treatment.^{18–19} Our results differ from these previous studies, showing an overall incidence of PONV and POV of only 17.9%/17.9% (Group S/Group R) and 12.8%/10.2% (Group S/Group R), respectively. The patient age range was 6–11 yr, which may be a factor in our results, as previous reports state that age ≥ 3 yr is an independent risk factor increasing POV.^{16–20} The type of surgical technique used for strabismus correction in children has been reported as a major factor in the incidence of POV.²¹ For example, myopexy is associated with a significantly higher incidence of POV, compared with the recess–resect technique. Our patients all underwent recess–resect surgery and the incidence of POV between our study and the results from a previous study done in a recess–resect group²¹ are comparable, although the main anaesthetic agents used were different (sevoflurane with or without remifentanyl vs propofol). Another factor related to PONV is the duration of surgery. Two studies^{16–20} determined that surgery length >30 min has a positive correlation with POV in children. The mean duration of surgery in our study was about 15 min. The anaesthetic agents used in our study may also contribute to the low incidence of PONV. Several studies have reported a lower incidence of PONV with sevoflurane compared with halothane.^{10–12} Most previous studies assessing PONV after paediatric strabismus surgery used halothane, which may partially explain the lower incidence in our study. The effects of remifentanyl on the incidence of PONV are less clear.

A previous report indicated that the incidence of POV in paediatric strabismus surgery with remifentanyl was comparable with that with propofol.²² A comparison of the effect of remifentanyl and fentanyl on POV in children undergoing strabismus surgery reported no differences between the two agents (49% vs 48%), but POV episodes per patient were significantly less frequent using remifentanyl (0.95 vs 2.2 episodes).⁹ Remifentanyl or fentanyl was used in addition to 2.5% sevoflurane and, thus, an influence of sevoflurane on POV could not be ruled out. Our results show that the use of remifentanyl in combination with sevoflurane did not increase the incidence of PONV, compared with sevoflurane alone. The dose of remifentanyl was based on a previous study showing administration of $0.25 \mu\text{g kg}^{-1} \text{min}^{-1}$ of remifentanyl reduced the required minimum alveolar concentration (MAC) of sevoflurane to a level associated with spontaneous patient awakening in children.²³ The MAC-awake of sevoflurane in children is 0.78% and gradually decreases to 0.60% in 12-yr-old subjects.^{24–25} Thus, we used 1% sevoflurane in combination with $0.25 \mu\text{g kg}^{-1} \text{min}^{-1}$ of remifentanyl to prevent awakening. We did not use remifentanyl as the sole anaesthetic agent because remifentanyl alone has been reported to increase the incidence of oculocardiac reflex.²⁶ This is a potential limitation of our study, as we did not examine PONV with remifentanyl alone, but rather in combination with sevoflurane. However, the sevoflurane concentration used in Group R was minimal, and we believe that combining the two drugs is more clinically relevant for general anaesthesia than using remifentanyl alone.

It has been reported that PONV after paediatric elective ambulatory surgery occurs most frequently during the first 3 h after anaesthesia.²⁷ In contrast, in our study, more patients experienced PONV at home rather than during their hospital stay, which was about 3 h on average. A higher incidence of POV out-of-hospital, compared with in-hospital, has been reported after paediatric strabismus surgery, although in that study, prophylactic antiemetic treatment was used.²⁸

Arterial pressure and heart rate were significantly lower in Group R than in Group S after tracheal intubation and skin incision, but were stable in both groups. Our results indicate that remifentanyl in combination with a low concentration of sevoflurane can be used successfully in paediatric strabismus surgery in the context of haemodynamic stability and PONV.

Pain is not severe after this kind of surgery and measurement and management of postoperative pain was not included in our study. We followed the institutional pain management guidelines, but no patient in our study required analgesics, similar to a previous study.²⁹ However, one study reported that pain was a significant predictor of PONV after paediatric strabismus surgery,⁸ so future studies may be improved by incorporating pain data.

In summary, the incidence of PONV after paediatric strabismus surgery using sevoflurane anaesthesia was

relatively low, compared with previous reports, and combining remifentanyl with sevoflurane did not increase the incidence.

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The English in this document has been checked by at least two professional editors, both native speakers of English. For a certificate, please see: <http://www.textcheck.com/certificate/WD7hJq>.

Conflict of interest

None declared.

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