Postoperative vomiting following strabismus surgery in paediatric out-patients: spontaneous versus controlled ventilation

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The study was designed to compare the frequency and severity of postoperative vomiting in paediatric out-patients receiving controlled ventilation (IPPV) or breathing spontaneously (SV) during anaesthesia for strabismus repair. One hundred and twenty unpremedicated children (ages 2–12 years) were studied in a randomized fashion. After intravenous induction of anaesthesia and tracheal intubation, patients breathed halothane 1–1.5 per cent inspired and N_2O 66 per cent in O_2 spontaneously (n = 60), or received IPPV, halothane 0.5–1 per cent, N_2O 66 per cent, and pancuronium 0.05 mg·kg^{-1}, which was reversed with neostigmine and atropine (n = 60). The incidence of vomiting with SV was 50 per cent (95 per cent confidence limits: 34.5–65.5 per cent) compared with 40 per cent (24.5–55.5 per cent) with IPPV ($p > 0.25$). Patients in the SV group experiencing emesis had longer operations than those not vomiting (mean ± SEM = 1.5 ± 0.1 vs 1.2 ± 0.1 hours, $p < 0.005$). This was not the case with IPPV. There was no correlation between age, sex, duration of surgery, or number of extraocular muscles repaired, and frequency or severity of vomiting or time to discharge. No significant advantage was afforded by IPPV over SV in the present study.

Key words

ANAESTHESIA: paediatric, ophthalmologic, outpatient; VOMITING: incidence; ANAESTHETIC TECHNIQUES: controlled/spontaneous ventilation.

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Vomiting is a distressing and potentially hazardous symptom occurring frequently in children following strabismus surgery.[1–4] Pretreatment with low-dose droperidol prior to manipulation of the eye has been shown to reduce the incidence of postanaesthetic vomiting significantly in children undergoing strabismus repair during controlled,[5] but not spontaneous, ventilation.[6] In addition, droperidol administration to children may slightly delay anaesthetic awakening,[6] and cause extrapyramidal syndromes.[7] Controlled ventilation (IPPV) with non-depolarizing muscle relaxants decreases volatile agent requirements, and may decrease the incidence of postoperative vomiting in adults.[8–10] This study was designed to compare the frequency and severity of postoperative vomiting in children undergoing strabismus repair receiving IPPV or breathing spontaneously (SV).

Methods

Institutional approval and informed consent from the parents were obtained. One hundred and twenty-seven children, ASA physical status I or II, scheduled for elective strabismus repair as outpatients were randomly assigned (using a table of random numbers) to breathe spontaneously (n = 62) or receive IPPV (n = 65). No premedication was given. After the patient entered the room, a precordial stethoscope, electrocardiogram, blood pressure cuff and doppler probe were applied. Anaesthesia was induced with thiopentone 5–7 mg·kg^{-1} IV followed by atropine 0.02 mg·kg^{-1} IV. Tracheal intubation was facilitated by succinylcholine 1.5 mg·kg^{-1} IV. Care was taken to avoid gastric inflation during the brief period of mask ventilation. Patients then breathed halothane 1–1.5 per cent inspired and N_2O 66 per cent in O_2 spontaneously (after recovery of neuromuscular function), or received IPPV, halothane 0.5–1 per cent inspired, N_2O 66 per cent in O_2 and pancuronium 0.05 mg·kg^{-1}, which was reversed with neostigmine 0.06 mg·kg^{-1} and atropine 0.02 mg·kg^{-1}. For both groups of

TABLE I Characteristics of children undergoing elective strabismus repair (mean ± SEM)

	Spontaneous ventilation	*Controlled ventilation*
Male/female	37/23	27/33
Age (years)	5.5 ± 0.4	5.7 ± 0.4
No. muscles repaired*	2 (1–4)	2 (1–4)
Length of surgery (hrs)	1.4 ± 0.1	1.4 ± 0.1

*Median (range).

patients fresh gas flows were adjusted, based on previous recommendations, to maintain normocarbia using a Bain anaesthetic circuit.[11,12] In the SV group, the fresh gas flow was at least twice the estimated normal minute ventilation, whereas for the IPPV group the fresh gas flow was 1000 ml + 100 mg·kg^{-1} (weight 10 to 30 kg) or 2000 ml + 50 mg·kg^{-1} (weight > 30 kg). Intravenous fluids (dextrose five per cent and saline 0.2 per cent) were administered to replace the estimated fluid deficit and the ongoing maintenance fluid requirements. No narcotics or neuroleptics were used. Patients were extubated after return of pharyngeal reflexes.

Frequency and severity of vomiting were evaluated every 15 minutes for two hours in the postanaesthetic recovery room by one observer (BR), who was unaware of the anaesthetic technique employed. The scoring method of Abramowitz[3] was used: briefly, a score of 0 indicated no vomiting; 1 = mild vomiting, occurring only once per 15 min observation period; 2 = moderate vomiting, 2 or 3 times per 15 min period; 3 = severe vomiting, 4 or more times per 15 min period, requiring treatment (metoclopramide and/or dimenhydrinate); and 4 indicated severe, persistent vomiting despite treatment. As well, the total number of vomiting episodes per child was recorded. Retching was considered as vomiting, but nausea was not evaluated because of the subjective interpretative nature of this symptom in children.[13] During the two hour study period analgesia was not administered. However, acetaminophen and/or codeine was given afterwards as required. After stabilization of vital signs, patients were discharged home when fully awake and able to tolerate oral fluids.

Statistical significance was determined using Chi square with the Yates correction for continuity and Fisher's exact test for intergroup differences in the incidence of vomiting and number of muscles repaired; Wilcoxon's rank sum test for severity of vomiting; linear regression and Spearman rank for parametric and non-parametric correlation respectively; and Student's t test for duration of surgery and time to discharge.[14,15] A p value < 0.05 was considered significant.

TABLE II Incidence of vomiting in patients undergoing strabismus surgery. Data are number of children vomiting/number of children in that group. Percentages in brackets

	Spontaneous ventilation	*Controlled ventilation*
Overall	30/60 (50)	24/60 (40)
Unilateral repair	11/24 (46)	10/21 (48)
Bilateral repair	19/36 (53)	14/39 (36)
One muscle	6/12 (50)	3/5 (60)
Two muscles	19/42 (45)	17/45 (38)
Three muscles	2/3 (67)	3/3 (100)
Four muscles	3/3 (100)	1/7 (14)

Results

Patient data are presented in Table I. Seven children (two in the SV group) were eliminated due to lost or incomplete records, leaving a total of 120 children for analysis. There were no significant intergroup differences in terms of age, sex, number of extraocular muscles repaired or duration of surgery. The incidence of vomiting with SV was 50 per cent (95 per cent confidence limits 34.5–65.5) compared with 40 per cent (24.5–55.5) with IPPV ($p > 0.25$) (Table II). Patients undergoing four muscle repairs appeared to vomit more often with SV than IPPV (100 vs 14 per cent) but this difference was not statistically significant ($0.05 < p < 0.1$) (Table II). Vomiting was almost always classified as mild (i.e. once per 15 min observation period) in 23 of 24 cases with IPPV (96 per cent) and 26 of 30 cases with SV (87 per cent), and did not require treatment. Only one child (SV) required treatment for persistent vomiting, and eventually was admitted for overnight hospitalization. However, some children did vomit more than once prior to discharge, although there were no intergroup differences. For example, there were 55 episodes of emesis in 30 children (SV group), and 43 episodes in 24 children with IPPV. This is broken down further in Table III. Patients in the SV group experiencing emesis had significantly longer operations than those children not vomiting (mean ± SEM = 1.5 ± 0.1 vs 1.2 ± 0.1 hours, $p < 0.005$). This was not the case with IPPV (Table IV). Time to discharge was similar in both

TABLE III Frequency of vomiting with spontaneous (n = 30 children, 55 episodes) versus controlled (n = 24 children, 43 episodes) ventilation

Number of vomiting episodes	*Spontaneous ventilation*	*Controlled ventilation*
1	14	15
2	10	5
3	3	1
4	2	2
>4	1	1

TABLE IV Duration of surgery (hours) in patients undergoing strabismus repair (mean ± SEM)

	Spontaneous ventilation	*Controlled ventilation*
Vomiting	1.5 ± 0.1*	1.4 ± 0.1
No vomiting	1.2 ± 0.1*	1.3 ± 0.1

*$p < 0.005$ within group.

TABLE V Time to discharge (hours) in patients undergoing strabismus repair (mean ± SEM)

	Spontaneous ventilation	*Controlled ventilation*
Overall	3.5 ± 0.2	3.2 ± 0.1
Vomiting	3.6 ± 0.3	3.2 ± 0.2
No vomiting	3.3 ± 0.2	3.1 ± 0.2

groups whether or not vomiting occurred (Table V). There was no correlation between age, sex, length of surgery or number of extraocular muscles repaired and frequency or severity of vomiting or time to discharge. There was no difference in the incidence of bradycardia during surgery between groups (two patients – SV, three patients – IPPV).

Discussion

Vomiting after strabismus repair is a common complication in children undergoing ophthalmic surgery.[1–6] In addition to being distressing to the patient, it may lead to aspiration, dehydration, electrolyte imbalance, ophthalmic wound contamination and delay of discharge from the hospital.[1,2] A high frequency of postoperative vomiting was observed prior to discharge in the present study. This is consistent with previous series.[3–6] It was not possible to demonstrate any significant reduction in frequency, incidence or severity of vomiting with IPPV compared with SV. Based on a power analysis, if IPPV truly diminishes the incidence of vomiting following strabismus surgery from 50 to 40 per cent, then in order to be 80 per cent certain of not committing a type II error, about 900 patients would be required.[16] Similarly, with a study population of 120 patients, there was an 80 per cent probability of detecting a reduction in vomiting from 50 to 25 per cent with IPPV vs SV, which represents a 50 per cent decrease in vomiting compared to control.[16]

Vomiting in spontaneously breathing patients was associated with longer more complex procedures such as four muscle repairs which was not the case with IPPV. This may be because controlled respiration with relaxant techniques allows the use of lighter levels of anaesthesia which can result in a decreased incidence of postoperative vomiting. This explanation is supported by the work of Bellville *et al.*[9,10] Their data suggest a dose–response relationship between level of anaesthesia and incidence of nausea and vomiting in over 3500 adults undergoing various surgical procedures. Patients who received a muscle relaxant were subjected to lighter levels of anaesthesia and generally had less nausea and vomiting than those deeply anaesthetized. The incidence of emetic symptoms in adults was shown to be particularly increased when deep levels of anaesthesia were employed during SV without relaxants for procedures lasting more than two hours.[9,10] In constrast, Nikki and Pohjola[17] could not demonstrate any differences in frequency of postoperative nausea and vomiting following ocular surgery in 235 adult patients receiving light, deep or local anaesthesia. Their anaesthetic techniques employed consisted of: (1) N_2O-relaxant-IPPV, (2) neurolept-relaxant-IPPV, (3) N_2O-halothane-SV, or (4) local anaesthesia.[17]

Another important factor determining the incidence of postoperative vomiting is the duration of surgery. Smith[18] reported a marked increase in vomiting with duration of anaesthesia in adults, and this has been confirmed in children.[19–20] In the present study, there was no correlation between duration of surgery and frequency or severity of vomiting with SV or IPPV. However, in the spontaneously breathing group, the duration of surgery was longer in those children who vomited than those who did not. That IPPV may offer advantages over SV in terms of postoperative vomiting is supported by Dyrberg[8] who found that when respiration was controlled and relaxant techniques were used, duration of anaesthesia up to three hours had little effect on the incidence of vomiting. In addition, the use of antiemetics such as droperidol was effective in reducing postoperative emisis after strabismus surgery with IPPV,[4,5] but not SV.[6] Thus, the present study documents that, in the absence of droperidol, type of ventilation (IPPV or SV) has no effect on the incidence or severity of vomiting following strabismus repair.

Patients receiving IPPV were all given a non-depolarizing relaxant (pancuronium) which was reversed with neostigmine and atropine. It has been suggested that reversal agents such as neostigmine/atropine may act as antiemetics.[22–24] For example, when atropine was combined with morphine as a premedicant, the incidence of emetic symptoms fell from 67 to 37 per cent. Furthermore, when atropine was administered alone, the incidence of emetic symptoms was reduced from 23 to 12 per cent.[25] Although muscle relaxants are not thought to influence postoperative vomiting, Janhunen and Tammisto[26] found a higher incidence of vomiting when reversal of neuromuscular blockade with neostigmine/atropine was omitted and patients were allowed to recover neuro-

muscular activity spontaneously. It appears that both scopolamine and atropine can act on the vomiting centre and may be effective antiemetics during the postoperative period.[27] In addition, it has been postulated that emetic symptoms may be mediated in part by the oculocardiac reflex via a cholinergic mechanism.[1,28] Therefore, the use of an anticholinergic or a muscle relaxant with significant vagolytic properties may reduce the incidence of vomiting following strabismus surgery. However, Hardy *et al.*[6] were unable to demonstrate any significant advantage of atropine or glycoyrrolate in reducing postoperative emesis in their patients (although these drugs did block the oculocardiac reflex effectively). Similarly, Karhunen *et al.*[29] were unable to document any significant benefit of pancuronium in blunting the reflex, although alcuronium and gallamine[30] may afford some protection. Since the children in the present study routinely received atropine at induction and there were no differences in triggering of the oculocardiac reflex between groups, this mechanism is unlikely to be involved.

The incidence of vomiting following strabismus repair in children was shown to be significantly reduced from 85 to 43 per cent when droperidol 0.075 $mg \cdot kg^{-1}$ was given before the end of surgery.[3] However, this incidence was still unacceptably high and Hardy *et al.*[6] attempted to further decrease this incidence by administering droperidol prior to manipulation of the eye. Their anaesthetic technique consisted of halothane-N_2O-SV. They found that droperidol was not effective in decreasing the incidence of postoperative vomiting with the dosage given (0.05 $mg \cdot kg^{-1}$). Eustis *et al.*[5] determined that when droperidol 0.025 $mg \cdot kg^{-1}$ was given before manipulation of the eye and ventilation was controlled, the incidence of vomiting prior to discharge after strabismus repair was significantly less than controls. However, this dose did not prevent vomiting after discharge from hospital. Droperidol 0.075 $mg \cdot kg^{-1}$ has recently been shown to be a highly effective preventative measure for reducing the incidence of emesis before and after discharge from hospital in children undergoing strabismus repair when the drug was given before manipulation of the eye and ventilation was controlled.[4,5] Although droperidol in children may slightly delay awakening time, time to discharge home is not significantly altered.[6] Similarly, Lerman *et al.*[4] found that children treated with droperidol recovered in a similar fashion to those receiving acetaminophen or codeine.

In summary, the study could not demonstrate any significant benefit of controlled vs spontaneous ventilation in reducing postoperative vomiting in children undergoing strabismus repair. However, controlled ventilation may offer theoretical advantages for long operations.

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Résumé

Cette étude était conçue afin de comparer la fréquence et sévérité du vomissement post-opératoire chez les patients pédiatriques externes admis pour correction de strabisme sous anesthésie générale en respiration spontanée (SV) ou ventilation contrôlée (IPPV). Cent vingt patients non prémédiqués âgés de 2 à 12 ans ont été étudiés d'une façon randomisée. Après l'induction intraveineuse de l'anesthésie et l'intubation trachéale les patients ont reçu de l'halothane 1–1.5 pour cent et protoxyde d'azote 66 pour cent avec O_2 soit en respiration spontanée ($n = 60$), soit en ventilation contrôlée de l'halothane 0.5–1 pour cent, protoxyde d'azote 66 pour cent et pancuronium 0.05 $mg \cdot kg^{-1}$, qui a été antagonisé avec la néostigmine et l'atropine ($n = 60$). L'incidence de vomissement en ventilation spontanée était de 50 pour cent (95 pour cent limite de confiance: 34.5–65.5 pour cent) comparé à 40 pour cent (24.5–55.5 pour cent) avec IPPV ($p > 0.25$). Les patients du groupe SV ayant accusé des vomissements ont subi des opérations de plus longue durée que ceux qui n'en ont pas eus (moyenne ± SEM = 1.5 ± 0.1 versus 1.2 ± 0.1 heures, $p < 0.005$). Ceci n'était pas le cas avec le groupe IPPV. Il n'y avait aucune corrélation avec l'âge, sexe, durée de la chirurgie ou le nombre de muscles extra-oculaires réparés avec la fréquence ou la sévérité des vomissements ou le temps du congé. Aucun avantage significatif n'a acquis par la ventilation contrôlée comparativement à la ventilation spontanée dans la présente étude.