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Prevention of vomiting after general anesthesia for pediatric ophthalmic surgery

We evaluated the effectiveness of a multifaceted general anesthesia protocol designed to minimize postoperative vomiting after pediatric eye surgery. A convenience sample of 150 consecutive children, aged 2 weeks to 18 years, who received general anesthesia for pediatric ophthalmic surgery was studied. General anesthesia was administered with induction by mask for 82.7% of the children and intravenously using propofol in 17.3% of the children. Anesthesia was maintained using halothane or isoflurane, oxygen, and air mixture for all patients. Morphine sulfate was used for additional pain relief, up to 0.1 mg/kg. Gastric aspiration was performed after intubation for each child. Metoclopramide, 0.15 mg/kg, and 0.1 mg/kg of ondansetron were administered before the end of each operation.

Postoperatively, patients were monitored for vomiting for 24 hours. Postoperative vomiting occurred in 11 (7.3%) of 150 cases. Acute elevation of intraocular pressure was found in 5 of the 11 children who vomited. This vomiting was unresponsive to intravenous rescue ondansetron, but responded to lowering the intraocular pressure. The incidence of postoperative vomiting after general anesthesia for pediatric eye surgery can be substantially decreased by adopting a protocol designed to lessen the emetic effects of general anesthesia. Limited use of nitrous oxide for mask induction only, gastric emptying, and administration of metoclopramide and ondansetron intravenously in combination proved effective in reducing the incidence of postoperative vomiting.

Key words: Anesthesia, children, glaucoma, postoperative emesis, surgery.

Introduction

Postoperative vomiting after general anesthesia for pediatric eye surgery is a frequent complication. A 1994 survey[1] of the incidence of postoperative vomiting in 1,476 children receiving general anesthesia for all types of pediatric surgery reported an occurrence of 24%. The occurrence of postoperative nausea and vomiting (PONV) after strabismus eye surgery has been further reported in 50%,[2] 88%,[3] and 90%[4] of children. The incidence of PONV in children may be understated. Its occurrence in children clearly is evident when vomiting occurs. More subtle nausea and loss of appetite are less certain in children. The incidence of nausea in older patients occurred 2 1/2 times more frequently than vomiting.[5]

Postoperative nausea and vomiting is of multifactorial etiology. Age, gender, history of previous perioperative vomiting, obesity, history of motion sickness, type of surgery, preoperative hydration and fasting, choice of anesthetic agents, fluid management, use of opiates, administration of antiemetic medications, duration of anesthesia, anesthesia technique, and skill of the anesthesia provider all are potential factors that must be considered.

Vomiting is the most common reason for prolonged recovery and unanticipated admission of children to the hospital from the ambulatory surgical unit.[6] The present study reports the results of a pilot study of a combination of antiemetic measures to decrease the incidence of vomiting after general anesthesia is given for pediatric eye surgery.

Methods

From May 1997 through December 1998, 150 children operated on by 1 surgeon received general anesthesia by 1 anesthetist according to a predetermined protocol designed to reduce the occurrence of postoperative vomiting (Table).

With approval from the hospital investigational review board, 150 consecutive healthy children, ASA physical status I and II, aged 2 weeks to 18 years, and scheduled for elective ophthalmic surgery, were studied. Children who received general anesthesia for less than 45 minutes were excluded from the study. Instructions for preoperative fasting were given as follows. Children younger than 1 year who were receiving formula or breast milk were fed until 4 hours before surgery, and clear fluids were permitted for children younger

Table. Summary of anesthetic technique

Premedication
- Atropine sulfate: age < 2 years
- Midazolam (intravenous induction)
- No preoperative medication for other patients

Induction technique
- Mask inhalation
  - Oxygen/nitrous oxide/halothane
  - Intravenous catheter insertion
  - Muscle relaxation
  - Stomach decompression
- Intravenous induction
  - Oxygen/propofol/sodium pentothal
  - Muscle relaxation
  - Stomach decompression

Maintenance anesthesia
- Endotracheal tube
- Oxygen/air/halothane/isoflurane
- Muscle relaxation
- Morphine
- Metoclopramide
- Ondansetron

than 2 years until 2 hours before surgery. Patients older than 2 years fasted 6 hours preoperatively.

Mask induction was employed for 124 (82.7%) of 150 children. Children younger than 2 years received 0.02 mg/kg of atropine sulfate intramuscularly, 30 minutes before the induction of anesthesia. Midazolam, 0.50 mg/kg, was given by mouth preoperatively to 4 of these 124 children. Preoperative midazolam, 0.03 mg/kg, was given intravenously (IV) to the 26 (17.3%) patients whose anesthesia was induced intravenously. During each induction, 1 parent was present in the operating room until the child was no longer conscious.

Inhalational anesthesia was induced by mask using 70% nitrous oxide, 30% oxygen, and titration of halothane up to 3%. When an appropriate plane of anesthesia was achieved, a number 20, 22, or 24 IV catheter was placed, and infusion with lactated Ringer's solution commenced. To facilitate endotracheal intubation, a muscle relaxant (0.2 mg/kg of mivacurium IV or 0.6 mg/kg of rocuronium IV) was given. The patient was then preoxygenated and an endotracheal tube was placed. After intubation, nitrous oxide was discontinued for the remainder of the procedure. The stomach was then emptied using a Salem sump (Sherwood Medical, St. Louis, Mo). Children induced intravenously initially received 0.5 mg/kg IV of xylocaine or 50 to 100 mg IV of thiopental to prevent pain on injection with propofol. The patient received oxygen followed by 3 mg/kg IV of propofol. To facilitate tracheal intubation, 0.2 mg/kg IV of mivacurium or 0.6 mg/kg IV of rocuronium was administered. An endotracheal tube was placed in each patient. The stomach was then emptied with a Salem sump. Nitrous oxide was not used during IV inductions or to assist in the maintenance of anesthesia.

Perioperative monitoring was maintained with constant observation and use of a precordial stethoscope, electrocardiograph, end-tidal carbon dioxide monitor, oxygen saturation monitor, temperature monitor, automatic blood pressure recorder, and peripheral nerve stimulator.

Anesthesia was maintained with 70% air, 30% oxygen, and halothane or isoflurane. For additional analgesia, 0.05 mg to 0.10 mg/kg IV of morphine sulfate was given. Metoclopramide, 0.15 mg/kg IV, was given approximately 45 minutes before the end of each procedure, and 0.1 mg/kg IV of ondansetron was given approximately 20 minutes before the end of anesthesia. Lactated Ringer's solution was used intraoperatively for maintenance of intravenous fluids. Fluid requirements were calculated according to body weight. Children weighing 10 kg or less received approximately 4 mL/kg per hour; children between 10 and 20 kg received 40 mL plus 2 mL/kg per hour; and patients weighing 20 kg or more received approximately 60 mL plus 1 m/L/kg per hour. The fluid deficit was calculated and replaced. During the first hour, one half of the estimated fluid deficit was replaced. During the second and third hours, one quarter of the fluid deficit was replaced.

Postoperatively, patients were observed in a postanesthesia care unit for approximately 1 hour, followed by observation in an outpatient or inpatient hospital facility for 2 to 6 hours. No patients required admission overnight due to persistent vomiting. An IV line was maintained postoperatively with lactated Ringer's solution for children younger than 4 years for 1 to 2 hours, and until fluids were accepted by mouth by older children. Patients were monitored for vomiting, anorexia, or other clinical abnormalities for 24 hours after anesthesia. Parents of all children discharged home without reexamination by the operating surgeon and nurse anesthetist received a telephone call from the operating surgeon on the evening of surgery and the next morning who asked about the patient's activity, appetite, occurrence of vomiting, or presence of other problems.

When postoperative vomiting occurred while an IV line was in place, 0.1 mg/kg of ondansetron was administered intravenously to a maximum dose of 4 mg, to be repeated every 4 hours if necessary. No other antiemetics were administered.

All children who underwent intraocular surgery were examined by the operating surgeon and anesthetist 3 to 6 hours after surgery before discharge was considered. Routine intraocular pressure assessments were not performed. When ocular pain was reported, and/or when signs of glaucoma were found (cloudiness of the cornea, a deep anterior chamber, and no external filtration of aqueous humor after glaucoma surgery), the eye pressure was assessed using a handheld applanation tonometer. Elevation of the intraocular pressure greater than 30 mm Hg associated with discomfort and vomiting was treated by digital ocular pressure behind the filtration site or by IV administration of acetazolamide.

Results

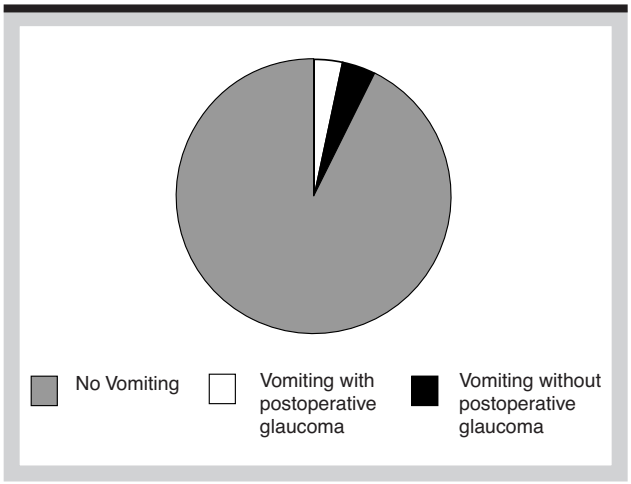
A total of 150 children were studied, and 17 different pediatric surgical ophthalmic procedures were performed (Figure 1). All patients were monitored successfully for 24 hours postoperatively for vomiting or other problems occurring before and after discharge from the hospital. Postoperative vomiting occurred in 11 (7.3%) of the 150 patients. No patients are known to have vomited after 24 hours after surgery.

Concomitant elevated intraocular pressure was found in 5 of these 11 patients during the 3- to 6-hour interval after surgery. When rescue ondansetron was administered to these 5 patients, no benefit was observed. Decreasing the eye pressure, however, provided an immediate antiemetic relief for each of these children within 30 minutes. Vomiting occurred in 6 (4.2%) of 144 children without evidence of an elevated eye pressure during the first 6 hours after surgery. When ondansetron was administered to the 6 patients without evidence of glaucoma, it effectively controlled the emesis without permitting a recurrence.

Cataract extraction was followed by vomiting in 4 (16%) of 25 children, and this was associated with the occurrence of glaucoma in 1 patient. Only 1 child of 12 (8.3%) who underwent strabismus surgery vomited. Vomiting occurred in 4 of 82 (4.9%) patients who underwent surgery for glaucoma. These 4 children who vomited were 13.8% of 29 patients who underwent trabeculectomy surgery, and each vomited associated with postoperative glaucoma (Figure 2).

The duration of anesthesia was recorded from induction until discharge from the operating room. A longer period of general anesthesia was found to be associated with a greater incidence of vomiting in our patients (Figure 3). No vomiting occurred in those 21 children receiving general anesthesia for 45 to 60 minutes. Two of 41 (4.9%) children receiving anesthesia for 1 to 2 hours vomited, and 9 of 88 (10.2%) children receiving anesthesia for 2 to 3 hours vomited. All children who vomited after cataract or glaucoma surgery were in the group of 88 children whose duration of anesthesia was 2 to 3 hours. Vomiting occurred in each age group, with the most frequent occurrence in children aged 5 through 9 years (Figure 4). In that age group, 6 of 36 (16.7%) patients vomited, and each of these affected children required surgery for 2 to 3 hours.

Figure 1. Occurrence of postoperative vomiting following 150 consecutive procedures



Discussion

Postoperative vomiting after general inhalation anesthesia for pediatric eye surgery was reduced to an occurrence rate of 7.3% when a specific anesthetic technique was employed. This was accomplished in 150 consecutive cases by adopting an anesthetic program designed specifically to lessen the risk for this postoperative problem.

Propofol was used, and it is an effective and rapid induction agent that would not be expected to contribute to the emetic risk of general anesthesia.[7-10]

For more than 25 years, controversy over whether

Figure 2. Occurrence of vomiting vs ophthalmic procedure

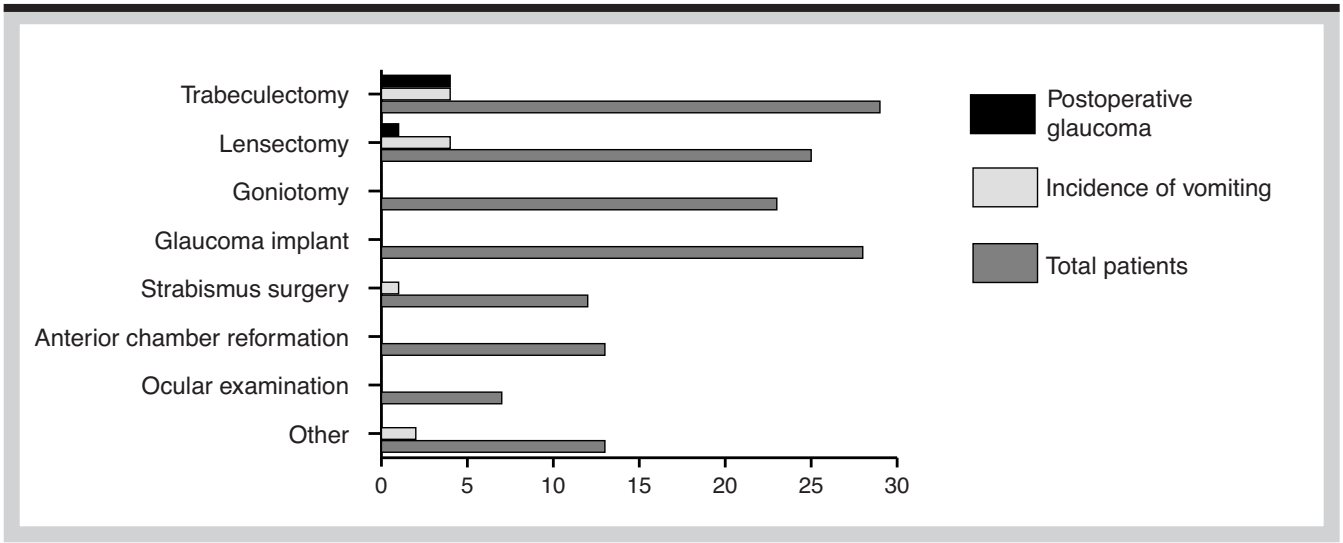


Figure 3. Occurrence of postoperative vomiting vs duration of surgery

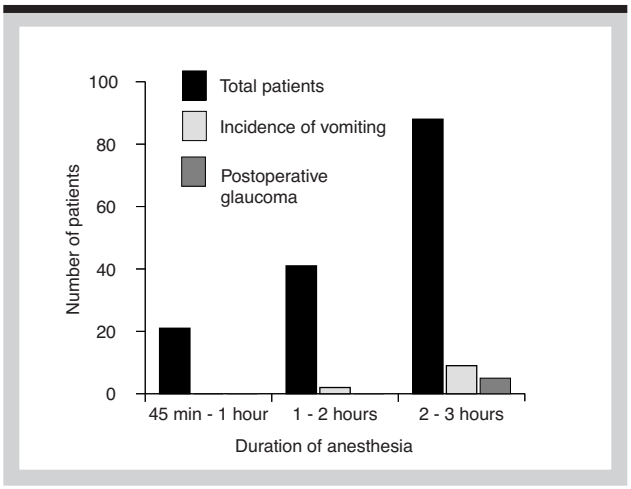
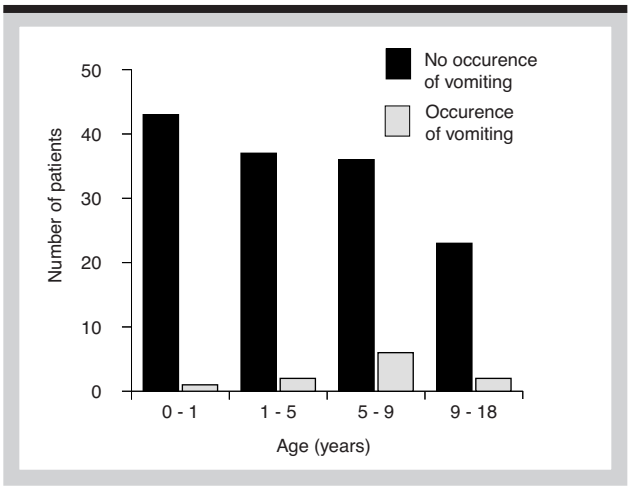


Figure 4. Occurrence of postoperative vomiting vs patient age



nitrous oxide increases the incidence of postoperative vomiting has been debated.[11-13] A 1996 review[14] of 27 studies of the association between nitrous oxide and PONV found a significant link in 24 of those studies. Nitrous oxide has been considered to cause vomiting as a result of bowel distention, reduced gastric motility, increased middle ear pressure, or by interaction with endogenous opiate receptors.

Meta-analysis of 26 published trials with separate nitrous oxide and non-nitrous oxide groups revealed that omission of nitrous oxide reduced the risk of PONV by 28%.[15] This report included data relating to pediatric strabismus surgery. In the pediatric strabismus patients, PONV occurred in 52%, 60%, and 42% of the nitrous oxide groups and occurred in 53%, 23%, and 28% respectively of the comparison non-nitrous oxide patients.[15] Nitrous oxide did not cause an increase in vomiting when administered briefly to children undergoing myringotomy procedures.[16]

Metoclopramide was administered intravenously to each patient during surgery. Metoclopramide may reduce postoperative vomiting through several mechanisms. It is a dopamine antagonist but also has been found to bind the serotonin receptor.[17] Dopamine and serotonin, as well as endorphin and substance P, are neurotransmitters found in the brainstem vomiting centers.[18] Importantly, metoclopramide also increases gastric motor activity, which prevents gastric relaxation that must precede vomiting. In 126 unpremedicated children undergoing strabismus surgery, metoclopramide reduced the incidence of vomiting to 35% vs 59% of children in the placebo group receiving general anesthesia with halothane, nitrous oxide, and oxygen.[19]

Ondansetron was administered intravenously to each patient in our study near the termination of general anesthesia. This drug in numerous studies has been established as a safe and effective antiemetic in children undergoing general anesthesia.[20] Ondansetron also has been shown to be effective in treating established postoperative emesis and was used in our study as an effective rescue antiemetic.[21] Ondansetron is a selective serotonin ($5\text{-}HT_3$) antagonist that was first used effectively for the prevention of chemotherapy-induced vomiting.[22] We used a dose of 0.1 mg/kg to a maximum of 4 mg of ondansetron IV, which is greater than a more recent recommended dose of 0.05 mg/kg.[23] The halflife of IV ondansetron in children is 2.5 to 3.0 hours compared with 3.0 to 3.5 hours in adults.[24]

Because anesthesia was maintained on an inhalation anesthetic/oxygen/air mixture without nitrous oxide, morphine sulfate was administered intravenously as necessary in divided doses to maintain analgesia. The incorporation of rectal nonsteroidal agents, such as acetaminophen, might have permitted a decreased dose of morphine.

We feel that recovery from anesthesia was positively affected by adopting the anesthesia protocol described, which included a combination of antiemetic measures. No effort was made to discharge patients in an accelerated fashion, so no potential benefit of shortened postanesthesia care unit or hospital stays was realized.[25] The accelerated return to well-being, however, was conspicuous compared with an earlier cohort of our patients (authors' personal observation). Parents of infants and older children returning for further surgery frequently noted the substantial improvement in their children's recovery vs earlier hospital experiences. Parents of infants

described the absence of belching and flatus and a quicker return to a normal appetite for breast-feeding or a formula diet. Follow-up ophthalmic examinations after intraocular surgery performed on the afternoon or evening after surgery often found children resting comfortably in the company of relaxed parents, rather than agitated and vomiting in the company of concerned parents.

In the present study, a significant concomitant elevation of eye pressure was found in 5 of the 11 patients who vomited. Four of these occurrences followed glaucoma filtration surgery, and the fifth followed intraocular lens implantation. In each instance, it was felt that retained viscoelastic in the anterior chamber was the principal cause of the elevated eye pressure. Nausea and vomiting is a familiar and common complication of a rapid rise of intraocular pressure. In each of our patients, postoperative vomiting terminated after successful lowering of the intraocular pressure.

The prevention of postoperative emesis can contribute substantially to the success and comfort of pediatric eye procedures. Recognition of anesthetic and ocular causes of vomiting is helpful in the prevention and treatment of postoperative vomiting. With the use of a combination of measures designed to lessen postoperative emesis, postoperative vomiting occurred in only 4% of our patients who did not experience an elevated intraocular pressure after surgery. Early postoperative recognition of elevated intraocular pressure was essential in effectively treating vomiting that occurred and was associated with postoperative glaucoma.

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