

output results. As the common causes of intraoperative bradycardia are hypoxia or vagal activity, such therapy should consist of ventilation with oxygen and iv atropine. To obtain a rapid response, iv atropine should be administered before marked bradycardia is present.

REFERENCES

1. Smith RM: Preparing children for operation, *Anesthesia for Infants and Children*, 4th edition. St. Louis, Mosby, 1980, p 98
2. Holt AT: Premedication with atropine should not be routine. *Lancet* 2:984-985, 1962
3. Hendriks PH, Govaerts MGM: Pediatric premedication: Atropine or not. *Acta Anaesthesiol Belg [Suppl]* 31:195-196, 1980
4. Gregory GA: Induction of anesthesia, *Pediatric anesthesia*. New York, Churchill-Livingstone, 1983, p 441
5. Morton HJ, Thomas ET: Effect of atropine on the heart rate. *Lancet* 2:1313, 1958
6. Mountcastle VB: The heart as a pump, *Medical Physiology*, 14th edition. St. Louis, Mosby, 1980, pp 1000-1001
7. Friedman WF: The intrinsic properties of the developing heart. *Prog Cardiovasc Dis* 15:87-111, 1972

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Effect of Droperidol Pretreatment on Postanesthetic Vomiting in Children Undergoing Strabismus Surgery

J. LERMAN, M.D., F.R.C.P.C.,* S. EUSTIS, M.D.,† D. R. SMITH, M.D., F.R.C.S.C.‡

Vomiting is a frequent and often disturbing complication following strabismus surgery, particularly in children.¹⁻⁵ Droperidol, a potent antiemetic, reduces the incidence of vomiting after many types of surgery, including strabismus surgery.⁶⁻¹⁴ Abramowitz *et al.* reported that intravenous droperidol $0.075 \text{ mg} \cdot \text{kg}^{-1}$ reduces the incidence of vomiting in children undergoing strabismus repair from 85% (control group) to 43% when administered after manipulation of the eye.¹ However, Meyers and Tomeldan observed that intramuscular droperidol $0.10 \text{ mg} \cdot \text{kg}^{-1}$ reduces the incidence of vomiting after eye surgery in adults to 10% when administered preoperatively and before manipulation of the eye.¹⁵ The lower incidence of vomiting in the latter study may be attributed, in part, to the more effective antiemetic action of droperidol when administered before manipulation of the eye rather than afterward. We speculated that if intravenous droperidol were administered before manipulation of the eye, the incidence of vomiting after strabismus repair in children might be reduced to a similar extent as in adults.¹⁵ Therefore, we determined the incidence of

vomiting after strabismus repair in children who received intravenous droperidol pretreatment, or one of the routine postanesthetic analgesics used in our institution: rectal acetaminophen or intramuscular codeine.

METHODS

With approval from the Committee on Human Research, a prospective, randomized study was undertaken. Informed written consent was obtained from the parents of 100 children scheduled for elective strabismus repair. The children were ASA Physical Status 1 or 2, fasting, unpremedicated, and older than 2 yr of age. Children with a history of motion sickness or vomiting after previous strabismus surgery were not excluded from the study.

The children were randomly assigned to one of three treatment groups: intravenous droperidol ($0.075 \text{ mg} \cdot \text{kg}^{-1}$) ($n = 31$); rectal acetaminophen ($10 \text{ mg} \cdot \text{kg}^{-1}$) ($n = 35$); or intramuscular codeine ($1.5 \text{ mg} \cdot \text{kg}^{-1}$) ($n = 34$). Droperidol was given at induction of anesthesia immediately after succinylcholine. Acetaminophen and codeine were given in the postanesthetic room (PAR) when the children were arousable. Acetaminophen was administered instead of a placebo to alleviate any possible discomfort after surgery. Intramuscular codeine was included as the third treatment after it was incriminated as a possible cause of vomiting after strabismus repair by one of our ophthalmologists. §

After a precordial stethoscope, electrocardiogram, blood pressure cuff, and Doppler probe were applied, general anesthesia was induced with intravenous thiopental ($5 \text{ mg} \cdot \text{kg}^{-1}$), atropine ($0.02 \text{ mg} \cdot \text{kg}^{-1}$), and succinyl-

* Assistant Professor, Director of Anaesthesia Research.

† Fellow in Ophthalmology.

‡ Assistant Professor of Ophthalmology.

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Address reprint requests to Dr. Lerman: Department of Anaesthesia, The Hospital for Sick Children, 555 University Avenue, Toronto, Ontario M5G 1X8.

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§ Smith DR: Personal communication.

choline ($1.5 \text{ mg} \cdot \text{kg}^{-1}$). The lungs were ventilated with 100% oxygen by mask after administration of succinylcholine. Care was taken to avoid inflation of the stomach. The trachea was then intubated and the lungs ventilated mechanically with a mixture of halothane (0.5–1.25%), nitrous oxide (70%), and oxygen (30%). Nondepolarizing muscle relaxants were not used. Intravenous fluids were administered to replace the estimated fluid deficit and the ongoing maintenance fluid requirements. Gastric contents were not aspirated. At the completion of surgery, the children were extubated when their gag reflex had returned. The children returned to the ward after recovering in the PAR. Intramuscular dimenhydrinate (1.0 – $1.5 \text{ mg} \cdot \text{kg}^{-1}$) was administered to any child with Grade 2 or 3 vomiting (table 1). Acetaminophen ($10 \text{ mg} \cdot \text{kg}^{-1}$ per rectum) was administered to any child in the droperidol group who experienced pain after surgery. Clear fluids were offered to the children as soon as they were awake enough to drink. Children were discharged on the evening of surgery, providing they fulfilled three discharge criteria: 1) stable vital signs; 2) clear sensorium; and 3) tolerating fluids.

We recorded the demographic data for the three groups of children as follows: age; number of extraocular muscles repaired; duration of anesthesia; incidence of delayed extubation; and, the incidence of overnight admissions. The nurses in the PAR and on the ward recorded the time and severity (table 1) of each episode of vomiting and the time at which oral fluids were tolerated. Retching was included in the incidence of vomiting. The nurses also recorded the PAR recovery scores,¹⁶ the duration of stay in the PAR, the post anesthetic pain scores,¹¹ and the time to discharge from the hospital. The parents of each child were contacted 72–96 h after discharge from the hospital by one of the authors to determine the incidence and severity of vomiting after discharge.

Statistical significance ($P < 0.05$) was determined using the Fisher exact test, Chi-square analysis with the Yates correction, and the Mann-Whitney U-test with the Bonferroni correction for the incidence of vomiting, delayed extubations, number of muscles repaired, the PAR recovery and pain scores; and ANOVA and the Student-Neuman-Keuls test for the patients' ages, duration of anesthesia, duration of stay in the PAR, time to discharge from hospital, and the time interval from admission to PAR to tolerating fluids.

RESULTS

The mean age, number of extraocular muscles repaired, duration of anesthesia, and incidence of delayed extubation did not differ significantly among the three treatment groups (table 2). Delayed extubation (greater than 10 min after discontinuation of the anesthetic) was

TABLE 1. Emesis and Recovery¹⁶ Scores

Emesis Score	
Grade 1	Isolated episode(s) of vomiting in which antiemetic medication was not required and/or hospitalization was not prolonged.
Grade 2	Episodes of vomiting that require antiemetic medication. This was arbitrarily defined as three episodes of vomiting/h or four consecutive h with one or more episode of vomiting/h.
Grade 3	Uncontrolled vomiting, despite antiemetic medication. Patient required hospitalization overnight.
Recovery Score	
Awake	
Fully awake	2
Arousable	1
Not responding	0
Ventilation	
Cough or cry	2
Breathes easily	1
Airway requires attention	0
Movements	
Purposeful	2
Involuntary	1
Not moving	0

observed in one child who received droperidol and one who received rectal acetaminophen.

When the incidence of vomiting pre-discharge, post-discharge, and overall were compared for the three treatments, significantly fewer children treated with droperidol vomited pre-discharge and overall compared with children treated with acetaminophen and codeine ($P < 0.05$) (table 2). The incidence of vomiting pre-discharge was only 10%

TABLE 2. Summary of Demographic Data and Incidence of Vomiting in Three Treatment Groups

	Droperidol	Acetaminophen	Codeine
Number of children	31	35	34
Age (yr)	6.3 ± 3.3	6.5 ± 3.2	5.9 ± 17.5
Number of muscles repaired*	2 (1–4)	2 (1–3)	2 (1–4)
Duration of anesthesia (min)	54.2 ± 39.0	48.9 ± 20.4	54.3 ± 3.4
Incidence of delayed extubation*	1	1	0
Incidence of overnight admissions	1 [3]	2 [6]	4 [12]
Incidence of vomiting			
Predischarge	3 [10]	16 [46]†	16 [47]†
Postdischarge only	2 [6]	5 [14]	7 [21]
Total	5 [16]	21 [60]†	23 [68]†

Mean \pm SD.

Numbers in brackets indicate the per cent of children.

* Median (range).

† Significantly greater than droperidol ($P < 0.05$).

† Modified pain score excluded posture: maximum 10 points.¹⁷

TABLE 3. Postanesthetic Scores and Times

	Droperidol	Acetaminophen	Codeine
PAR scores*			
Admit	2 (0-6)	2 (0-4)	3 (0-6)
5 min	3 (1-6)	3 (1-6)	4 (1-6)
15 min	4 (1-6)	4 (1-6)	6 \pm (1-6)
30 min	6 (3-6)	5 (3-6)	6 (1-6)
Discharge	6 (3-6)	6 (5-6)	6 (4-6)
Time in PAR (min)	71 \pm 38.7	63 \pm 26.1	65 \pm 20.8
Number of patients discharged same day	30	33	30
Time to discharge from hospital (h) \dagger	6.41 \pm 1.6	7.14 \pm 1.7	6.68 \pm 2.1

Mean \pm SD.

* Median (range).

 \dagger Time interval from admission to postanesthetic room (PAR) to discharge from hospital for patients discharged the same day. \ddagger Significantly different from droperidol ($P < 0.05$).

with droperidol compared with 46% with acetaminophen and 47% with codeine ($P < 0.05$) (table 2). None of the children who were given droperidol required hospitalization overnight because of vomiting, whereas two of those given acetaminophen and four of those given codeine remained overnight (Grade 3 vomiting) (table 2). One child who was given droperidol required hospitalization overnight because of drowsiness and refusal to drink. None of the children in any treatment group experienced retching without vomiting. To determine the incidence of vomiting postdischarge, 95% of the parents were contacted by telephone. The incidence of vomiting postdischarge with droperidol (6%), did not differ significantly from that with acetaminophen (14%), or codeine (21%) (table 2). None of the children who vomited after discharge from hospital required readmission for vomiting.

The median PAR recovery scores, time in the PAR, and time to discharge from the hospital (not including overnight admissions) did not differ significantly among the three treatment groups (table 3), with the exception of the PAR scores for codeine and droperidol at 15 min. The postoperative pain scores did not differ significantly among the three groups at any time. Only two children in the droperidol group required acetaminophen for postoperative pain. The time from admission to PAR to drinking fluids did not differ significantly among the three groups.

The incidence of vomiting did not differ significantly among three age groups⁷: 2-5 yr, 6-10 yr, and older than 10 yr of age, for any treatment.

DISCUSSION

Although droperidol has proven to be an effective antiemetic for many surgical procedures in children,⁷⁻¹³ the incidence of vomiting after strabismus repair remains un-

acceptably high.¹⁻³ We found that the incidence of vomiting pre-discharge in children who received intravenous droperidol 0.075 mg \cdot kg⁻¹ before manipulation of the eye is similar to that reported by Meyers and Tomeldan,¹⁵ but significantly less than that reported by Abramowitz *et al.*¹ In the latter study, droperidol was given after manipulation of the eye. The reduced effectiveness of droperidol in the latter study, may be attributed in part to the administration of droperidol after the stimulus to vomit was already present. In order to reduce the incidence of vomiting after strabismus repair in children to a clinically acceptable level, intravenous droperidol should be given at induction of anesthesia (approximately 10 minutes before manipulation of the eye).¹⁸

The incidence of vomiting in the acetaminophen group is similar to that in control groups undergoing strabismus repair in some studies^{9,19} but is significantly less (85%) than that in the study by Abramowitz *et al.*¹ This latter difference may be attributed to several factors. First, the administration of intravenous atropine may have reduced the incidence of vomiting in this study.²⁰ Second, we administered acetaminophen to the control group to provide postoperative analgesia. Although acetaminophen itself does not prevent vomiting, it may have contributed to a reduction in the incidence of vomiting indirectly by alleviating postoperative eye pain.²¹ Third, although the stomach was not decompressed, we avoided gastric inflation by carefully ventilating the lungs only after administration of succinylcholine and when the child was apneic. Fourth, the effect of nitrous oxide on the gas volume in the stomach was minimized by the brief duration of surgery (table 2).²²

The potential side effects of droperidol may reduce its use in children undergoing elective strabismus repair.^{1,3,23-26} Prolonged sedation, hypotension, restlessness, and extrapyramidal side effects have been associated with the use of droperidol in children.²⁴ Despite the risk of prolonged sedation,²⁵ the recovery room scores and times to discharge from the hospital in the droperidol group did not differ significantly from the acetaminophen group (table 3). It was noted that those children who received droperidol had to be aroused more vigorously to encourage them to drink compared with children in the other two treatment groups, although there was no objective evidence of prolonged sedation in the droperidol group. Furthermore, the time interval from admission to PAR until the children were tolerating fluids did not differ significantly among the three groups. Anticholinergic drugs have been recommended to prevent many of the side effects caused by droperidol, including anxiety and restlessness, and to attenuate the oculocardiac reflex. Neither anxiety nor restlessness was observed in this study. This may be attributed, in part, to the administration of intravenous atropine coincidental with droperidol at induction of anesthesia.

If the incidence of vomiting postdischarge had been ignored in this study, then the adjusted incidence of vomiting in the acetaminophen and codeine groups would have been 46% and 47%, respectively (the predischage incidences, table 2). These incidences are significantly less than the incidence of vomiting in the control group (85%) in the study by Abramowitz *et al.*, but are similar to that in the study by Hardy *et al.* (62.5%).¹⁹ The high incidence of vomiting after discharge from the hospital underscores the necessity for close follow-up of all patients after surgery and discharge from the hospital in order to monitor accurately the incidence of postanesthetic vomiting. Failure to do so may result in a falsely low incidence of postoperative complications.

Although it is well known that narcotics increase the incidence of postanesthetic vomiting,^{5,27,28} codeine did not significantly increase the incidence of vomiting above that for acetaminophen in this study. The incidence of vomiting predischage, postdischarge, and in total did not differ significantly between the codeine and acetaminophen groups. The authors conclude that in comparison to acetaminophen, intramuscular codeine does not increase the incidence of vomiting after strabismus repair.

In summary we have shown that droperidol 0.075 mg · kg⁻¹ significantly reduces the incidence of vomiting in children undergoing strabismus repair. Recovery will be comfortable and uncomplicated, and the need for narcotic analgesia will be precluded in the postoperative period. In this way, strabismus surgery will be a more positive experience for our patients.

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REFERENCES

1. Abramowitz MD, Oh TH, Epstein BS, Ruttiman UE, Friendly DS: The antiemetic effect of droperidol following outpatient strabismus surgery in children. *ANESTHESIOLOGY* 59:579-583, 1983
2. Weinstock SM, Flynn JT: Brief hospital admissions for pediatric strabismus surgery. *Am J Ophthalmol* 80:525-529, 1975
3. Abramowitz MD, Elder PT, Friendly DS, Broughton WL, Epstein BS: Antiemetic effectiveness of intraoperatively administered droperidol in pediatric strabismus outpatient surgery—Preliminary report of a controlled study. *J Pediatr Ophthalmol Strabismus* 18:22-27, 1981
4. Hadaway EG, Ingram RM, Traynar MJ: Day care surgery for strabismus in children. *Trans Ophthalmol Soc UK* 97:23-25, 1977
5. Rowley MP, Brown TCK: Postoperative vomiting in children. *Anaesth Intensive Care* 10:309-312, 1982
6. Romano P, Robinson J: General anesthesia morbidity and mortality in eye surgery at a children's hospital. *J Pediatr Ophthalmol Strabismus* 18:17-21, 1981
7. Fozard JR, Manford MLM: A controlled clinical trial of oral droperidol and droperidol plus diazepam for premedication in children. *Br J Anaesth* 49:147-151, 1977
8. Rita L, Goodarzi M, Seleny F: Effect of low dose droperidol on postoperative vomiting in children. *Can Anaesth Soc J* 28:259-262, 1981
9. Iwamoto K, Schwartz H: Antiemetic effect of droperidol after ophthalmic surgery. *Arch Ophthalmol* 96:1378-1379, 1978
10. McGarry PMF: A double-blind study of diazepam, droperidol and meperidine as premedication in children. *Can Anaesth Soc J* 17:157-165, 1970
11. Winning TJ, Brock-Utne JG, Downing JW: Nausea and vomiting after anesthesia and minor surgery. *Anesth Analg* 56:674-677, 1977
12. Patton CM, Moon MR, Dannemiller FJ: The prophylactic antiemetic effect of droperidol. *Anesth Analg* 53:361-364, 1974
13. Korttilla K, Kauste A, Auvinen J: Comparison of domperidone, droperidol and metoclopramide in the prevention and treatment of nausea and vomiting after balanced general anesthesia. *Anesth Analg* 58:396-400, 1979
14. Mortensen PT: Droperidol (Dehydrobenzperidol®): Postoperative anti-emetic effect when given intravenously to gynaecological patients. *Acta Anaesthesiol Scand* 26:48-52, 1982
15. Meyers EF, Tomeldan SA: Glycopyrrolate compared with atropine in prevention of the oculocardiac reflex during eye-muscle surgery. *ANESTHESIOLOGY* 51:350-352, 1979
16. Steward DJ: A simplified scoring system for the post-operative recovery room. *Can Anaesth Soc J* 22:111-113, 1975
17. Hannallah RS, Broadman LM, Belman AB, Abramowitz MD, Epstein BS: Control of post-orchiopey pain in pediatric outpatients: Comparison of two regional techniques (abstract). *ANESTHESIOLOGY* 61:A429, 1984
18. Cressman WA, Plostinieks J, Johnson PC: Absorption, metabolism and excretion of droperidol by human subjects following intramuscular and intravenous administration. *ANESTHESIOLOGY* 38:363-369, 1973
19. Hardy JF, Charest J, Girouard G, Lepage Y: Nausea and vomiting after strabismus surgery in preschool children. *Can Anaesth Soc J* 33:57-62, 1986
20. Palazzo MGA, Strunin L: Anaesthesia and emesis. I: Etiology. *Can Anaesth Soc J* 31:178-187, 1984
21. Palazzo MGA, Strunin L: Anaesthesia and emesis. II: Prevention and management. *Can Anaesth Soc J* 31:407-415, 1984
22. Eger EI II: Nitrous oxide transfer to closed spaces, *Anesthetic Uptake and Action*. Edited by Eger EI II. Baltimore, Williams and Wilkins, 1974, pp 171-174
23. Smith TC, Cooperman LH, Wollman H: History and principles of anesthesiology, *Basis of Pharmacological Therapeutics*, 6th edition. Edited by Gilman AG, Goodman LS, Gilman A. Philadelphia, MacMillan Publishing, 1980, p 270
24. Dupre LJ, Stieglitz P: Extrapyramidal syndromes after premedication with droperidol in children. *Br J Anaesth* 52:831-833, 1980
25. Loeser EA, Bennett G, Stanley TH, Machin R: Comparison of droperidol, haloperidol, and prochlorperazine as postoperative anti-emetics. *Can Anaesth Soc J* 26:125-127, 1979
26. Morrison JD, Clarke RSJ, Dundee JW: Studies of drugs given before anaesthesia XXI: Droperidol. *Br J Anaesth* 42:730-735, 1970
27. Wilton NC: The use of opiates in pediatric outpatient anaesthesia (abstract). *ANESTHESIOLOGY* 61:A428, 1984
28. Clarke RSJ: Nausea and vomiting. *Br J Anaesth* 56:19-27, 1984