Original Article

Post-operative vomiting after pediatric strabismus surgery: A comparison of propofol versus sevoflurane anaesthesia

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Abstract

Background and Aims: Squint surgery is a risk factor for postoperative vomiting (POV) in children. This study was designed to compare the incidence of POV in children undergoing strabismus surgery under balanced anesthesia with sevoflurane versus intravenous anesthesia with propofol.

Material and Methods: In this prospective randomized controlled study conducted in a tertiary care ophthalmology hospital, 70 ASA I-II children aged 1-12 years undergoing strabismus surgery were randomized to two groups –Group S (sevoflurane-based anesthesia) and Group P (propofol-based anesthesia) for maintenance. The surgical details, intraoperative hemodynamic parameters, recovery characteristics, and emergence delirium were recorded. Any episode of postoperative vomiting in the 0-2 hours, 2-6 hours, and 6-24 hours period was noted. Rescue antiemetic was administered if there was more than one episode of vomiting.

Results: Both the groups were similar with respect to demographic and surgical details. The average duration of surgery was 118.2 ± 41.88 min in group S and 137.32 ± 39.09 min in group P ($P = .05$). Four children in group S (11.4%) and one child in group P (2.9%) had POV in the first 24 hours but this was not statistically significant ($P = .36$). The median time to discharge from post anesthesia care unit was significantly less ($P = .02$) in the P group (50 min) than in the S group (60 min).

Conclusion: Propofol-based anesthesia does not offer advantage over sevoflurane, in reducing POV after squint surgery, when dual prophylaxis with dexamethasone and ondansetron is administered. It, however, reduces the duration of stay in the post anesthesia care unit.

Keywords: Pediatric, postoperative vomiting, propofol, sevoflurane, strabismus

Introduction

Children undergoing strabismus surgery have a high risk for postoperative vomiting (POV). Squint surgery is the only surgical procedure included in the established POV risk score in children. This postoperative vomiting in children (POVOC) score also includes age ≥3 years, duration of surgery ≥30 minutes, and history of POV/motion sickness in child or family history of postoperative nausea and vomiting (PONV) as the other three risk factors.[1] The incidence of POV ranges from 41% to 88% in the absence of prophylaxis.[2] Retching and vomiting may lead to systemic side effect like dehydration, delayed oral intake, dyselectrolytemia, and ocular problems like intramuscular and subconjunctival bleeding. It may also lead to delayed

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discharge, unforeseen hospital admission, discomfort for the child, and parental dissatisfaction.[2,3] Antiemetics like dexamethasone (glucocorticoid), ondansetron (5 HT3 antagonist), droperidol, dimenhydrinate (antihistamine), and metoclopramide (prokinetic) have been used for prophylaxis and treatment of POV. Super hydration, supplementation with regional blocks, avoidance of nitrous oxide, use of total intravenous anesthesia (TIVA), avoidance of opioids and reversal agent, and adjuvant use of dexmedetomidine are the other maneuvers attempted to reduce the incidence of POV in strabismus surgery.[4-6] Establishment of strabismus bundle and ensuring adherence to same, similar to the enhanced recovery after surgery protocols, has greatly helped in reducing POV by providing uniformity of care.[6,7]

Apfel *et al.* found total intravenous anesthesia using propofol and remifentanil to be advantageous compared to inhalational anesthesia in reducing POV.[8] The use of multimodal antiemetic agents is more beneficial than a single agent prophylaxis, especially in surgeries of longer duration, inpatients, and those with a high risk of PONV. Dual and even triple prophylaxis has been advocated in children with high risk of POV.[9] This study was designed to compare the effects of sevoflurane-based versus propofol-based anesthesia for maintenance, in children undergoing strabismus surgery. The primary outcome was to compare the incidence of postoperative vomiting between the two groups. The secondary outcome was to compare the intraoperative hemodynamic parameters, recovery characteristics, and incidence of emergence agitation between the two groups. This study is unique in being the first to compare sevoflurane (without nitrous oxide) and propofol as agents for maintenance of anesthesia in squint surgery in children aged 1-12 years.

Material and Methods

This prospective blinded (participant and outcome assessor) randomized controlled study was conducted between February 2021 and August 2022 at a tertiary care eye center in South India after approval of the institutional ethics committee and CTRI registration (CTRI/2021/03/031859). Seventy ASA I-II children aged 1-12 years undergoing strabismus surgery under general anesthesia were recruited after obtaining a written parental consent. Patients with a known allergy to propofol, those with a known difficult airway, and those with a severe neurological disorder were excluded from the study. This study complies with the Consolidated Standards of Reporting Trials statement for reporting of randomized controlled trials [Figure 1].

All patients underwent routine preoperative evaluation for squint surgery. Details of the anesthetic technique and study protocol were explained to the parent at the preoperative visit.

They were randomized to two groups –Group S (sevoflurane-based anesthesia) and Group P (propofol-based anesthesia) using a computer-generated simple random number table on MS excel. Group assignment was concealed in an opaque envelope that was opened before induction of anesthesia. All children were fasted for 6 hours prior to surgery. They were allowed water until 2 hours prior to induction. In the operating room (OR), standard monitors including ECG, pulse oximetry, NIBP with a recording interval of 5 min, temperature, capnography, and end-tidal inhalational agent monitoring were attached. Anesthesia was induced by inhalational (sevoflurane) or intravenous (propofol) technique depending on the absence or presence of an intravenous line, respectively. All children received fentanyl 2 μg/kg, dexamethasone 0.1 mg/kg, and ondansetron 0.1 mg/kg intravenously after induction. All children received neuromuscular blockade with atracurium 0.5 mg/kg. The trachea was intubated with an appropriate-sized endotracheal tube after mask ventilation for three minutes.

Postintubation, anesthesia was maintained with sevoflurane or propofol depending on the group they had been randomized to. The anesthesiologist in the OR was not blinded to the study group. In Group S, anesthesia was maintained with a mixture of air/O2/sevoflurane 2%-3%. In Group P, anesthesia was maintained with propofol at the rate of 10 mg/kg/hour for the first 10 minutes, 8 mg/kg/hour for the next 10 minutes, and 6 mg/kg/hour thereafter. They were ventilated with an air/O2 mixture. Depending on the need and duration of surgery, sevoflurane was delivered to attain age-appropriate MAC of 1-1.2 and propofol infusion adjusted ± 2 mg/kg/hour to maintain heart rate and blood pressure within 20% of baseline level. Prior to incision local anesthetic eye drops containing 0.5% proparacaine was applied to provide topical analgesia. All patients received intermittent boluses of atracurium and positive pressure ventilation during the surgery. A 20% increase in heart rate or BP was treated with fentanyl 1 μg/kg if it was deemed to be due to analgesia requirement by the attending anesthesiologist. The total dose of fentanyl and atracurium required was noted. Postinduction, all children received paracetamol 15 mg/kg intravenously for postoperative pain relief and Ringer lactate as intraoperative fluid. An acute decrease in heart rate by 20% or more associated with traction on ocular muscle was defined as oculo cardiac reflex (OCR). Any episode of OCR not responding to release of muscle traction was treated with atropine 0.01 mg/kg and recorded.

At the end of surgery, infusion of propofol or the administration of sevoflurane was discontinued and the neuromuscular

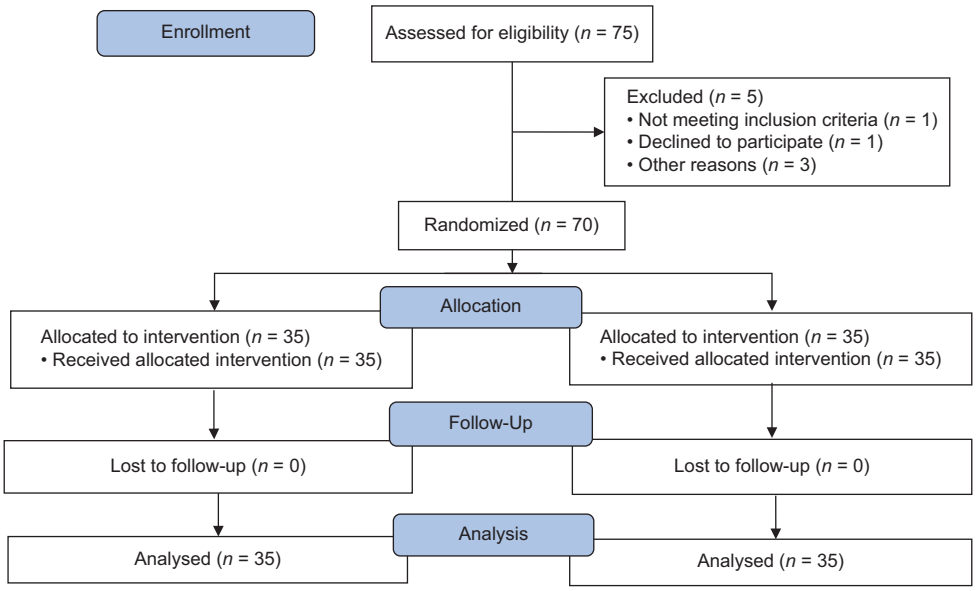

Figure 1: CONSORT flow diagram

blockade was reversed with neostigmine 0.05 mg/kg and glycopyrrolate 0.005 mg/kg and the patient's trachea was extubated when the child was awake with intact airway reflexes and purposeful movement. The duration of surgery and anesthesia and details of the surgery including side, number, and name of muscles and the operative procedure was noted.

The child was shifted to the post anesthesia care unit (PACU) for monitoring where an observer blinded to the study recorded the Pediatric Anesthesia Emergence Delirium (PAED) Score.[10] Children with PAED score >10 lasting >5 minutes was considered significant emergence agitation and were treated with midazolam 0.1 mg/kg intravenously. The child was discharged from the PACU once he achieved satisfied the following criteria: stable vital signs, patent airway without manipulation, oxygen saturation >95% on room air, and adequate control of pain. Any episode of postoperative vomiting in the 0-2-hour, 2-6-hour, and 6-24-hour period was recorded by an anesthesiologist blinded to the study. Retching was also considered as vomiting. We did not assess or record the incidence of nausea. Rescue antiemetic ondansetron 0.1 mg/kg was administered if there was more than one episode of vomiting. Metoclopramide 0.15 mg/kg was administered intravenously if there were more than two episodes of vomiting. The children were allowed orally upon request by the patient or parent. We followed our institutional pain management guideline of nurse-controlled analgesia for postoperative pain. It was treated with intravenous paracetamol 15 mg/kg and intravenous ketorolac 0.9 mg/kg if not responding to paracetamol.

The end point of the study was reached at 24 hours.

Statistics

The sample size was calculated assuming a type I error of 0.05. It was estimated that a sample size of 33 patients in each study group would achieve a power of 80% to detect a reduction by 80% in the primary outcome of interest, assuming a baseline POV risk of 35% from a previous study.[11] We enrolled 35 patients in each group to allow for possible dropouts. The statistical software SPSS 22.0 and R environment ver. 3.2.2 were used for the analysis of the data. Results on continuous measurements are presented as mean ± SD, if parametric and in median (interquartile range), if the distribution is non-Gaussian. Results on categorical measurements are presented in number (%). Chi-squared/Fisher's exact test was used to find the significance of study parameters on categorical scale, nonparametric setting, and for qualitative data analysis. Student's *t*-test was used to find the significance of normally distributed continuous data between the two groups. Continuous data with nonparametric distribution were analyzed using Mann-Whitney U test. A two tailed P value < .05 was considered significant.

Results

Seventy children were recruited, 35 in each group, and data from all of them were analyzed. The groups were similar with respect to demographic details like age, gender, weight, and ASA physical status [Table 1]. The median POVOC score was 3 in both the groups. The other surgical details like single eye versus both eye surgery, number of muscles operated upon, muscle involved in surgery, and the actual surgical procedure were similar in both groups and elaborated in Table 2. Fourteen of 35 patients (40%) in

group S and 18/35 patients (51.4%) in group P experienced at least one episode of OCR ($P = .34$), of whom 12 in group S and 16 patients in group needed atropine to treat the OCR ($P = .52$). There was no statistical difference in the average consumption of fentanyl ($P = .33$) and atracurium ($P = .15$) in both the groups. The average duration of surgery was 118.2 ± 41.88 min in group S and 137.32 ± 39.09 min in group P ($P = .05$). The mean duration of anesthesia was 139.11 ± 45.05 min in group S and 158.94 ± 37.64 min in group P ($P = .05$) [Table 3].

Four (4/35) children in group S (11.4%) and one (1/35) child in group P (2.9%) had POV in the first 24 hours but this was not statistically significant ($P = .36$). Among the children who received balanced anesthesia (group S) who had POV, two children had only one episode each, at 6 hours and 8 hours, respectively, postoperatively. The third child had four episodes of POV between 12 and 24 hours postoperatively and required intravenous maintenance fluid for the first 24 hours. The fourth child had three episodes of vomiting at one between 2-6 h and two episodes between 6 and 24 h. The single child in the P group who had POV had two episodes between 6 and 24 hours postoperatively. All the children who developed POV had a high POVOC score (≥3) [Table 4].

The median time to discharge from PACU was significantly less ($P = .02$) in the P group (50 min) than in the S group (60 min). The median PAED score in group S was 3 and 4 in group P ($P = .96$).

On comparing the hemodynamic parameters between the two groups, there was no significant difference in heart rate between them. The mean arterial pressure in group P remained significantly higher than in group S throughout the maintenance phase of anesthesia starting from the fifth minute postintubation up to 2 hours postintubation [Figure 2a and b].

Discussion

This study was designed to find any difference in the occurrence of POV between using propofol and sevoflurane for maintenance of anesthesia. The incidence of POV in our study is 11.4% in group S and 2.9% in group P. Inhalational versus intravenous anesthetic agents have been studied as a contributory factor for POV in squint surgery.[12-14] A Cochrane review by Ortiz *et al.* could not conclusively affirm the advantage of intravenous over inhalational anesthesia in reducing PONV or ED in pediatric outpatient surgery.[12] However, a similar systematic review and meta-analysis by Scheiermann *et al.* in pediatric inpatient surgery showed lower incidence of PONV after propofol (relative risk 0.68) than inhalational anesthesia.[13] Clinical and statistical heterogeneity has been cited as a shortcoming in both the reviews. Schaefer *et al.* commented that the use of a single antiemetic drug in squint surgery neutralizes the risk of POV offered by volatile anesthetics.[14]

This outcome has also been reported in a few German language studies.[3,15,16] Wolf *et al.* advocate a liberal PONV prophylaxis including TIVA in high-risk patients, as identified by the POVOC score > 2, while Biallas *et al.* found no difference in POV between the propofol and sevoflurane groups.[3,16]

Several authors have confirmed the useful effects of dual prophylaxis with dexamethasone and ondansetron for squint surgery.[5,9,17,18] The findings from our study indicate that no further statistically significant reduction in POV is offered by using propofol as a maintenance agent in strabismus surgery.

Table 1: Demographic characteristics

	Group S (n=35)	Group P (n=35)	P
Age (years)	7.3±2.96	6.78±2.78	0.45
Gender (M/F)	19/16	17/18	0.63
Weight (kg)	25.3±10.3	23.3±10.4	0.43
ASA physical status 1/2	27/8	31/4	0.20
POVOC score	3 (2-4)	3 (2-4)	1.0
L/H	4/31	4/31	

POVOC: postoperative vomiting in children; L=low risk (POVOC score ≤2); H=high risk (POVOC score >2)

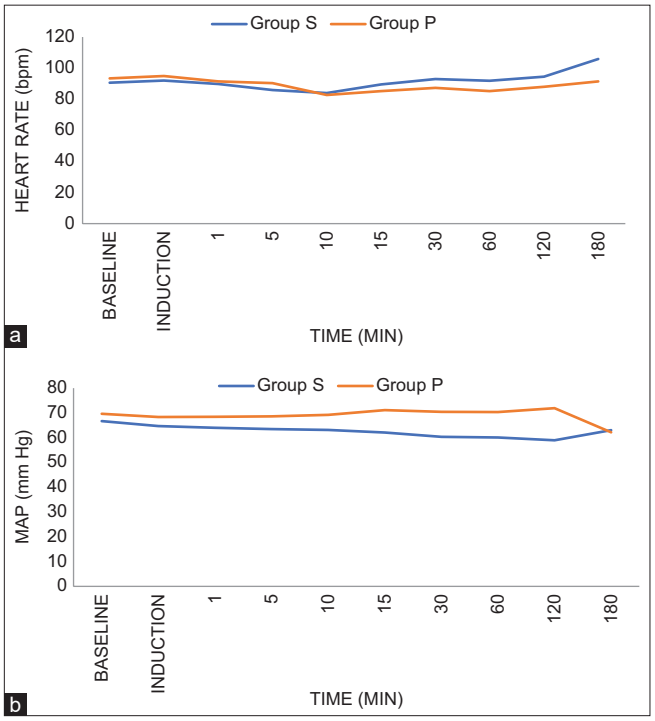

Figure 2: (a) Comparison of heart rate between sevoflurane and propofol group. (b) Comparison of mean arterial pressure (MAP) between sevoflurane and propofol group

Table 2: Surgical details

	Group S (*n*=35)	Group P (*n*=35)	*P*
Side Single eye/Both eyes	14/21	8/27	0.12
Number of muscles			
1	4	1	0.275
2	22	25	
≥3	9	9	
Type of surgery			
Recession	17	19	0.91
Recession±Resection/Myomectomy/Tenectomy/ Transposition	16	12	
Faden's procedure	0	2	
Transposition	1	1	
Resection	1	1	
Duration of surgery (minutes)	118.2±41.88	137.32±39.09	0.05
Muscles			
MR	28	25	0.96
LR	19	18	
SO	2	1	
IO	7	7	

MR: medial rectus; LR: lateral rectus; SO: superior oblique; IO: inferior oblique

Table 3: Anesthesia details

	Group S (*n*=35)	Group P (*n*=35)	*P*
OCR (*n*/%)	14 (40)	18 (51.4)	0.34
OCR needing treatment with atropine (*n*)	12	16	0.52
Duration of anesthesia (minutes)	139.11±45.05	158.94±37.64	0.05
Total Fentanyl (μg)	84.57±0.97	92.9±38.89	0.33
Total Atracurium (mg)	23.18±8.75	27.54±14.74	0.15
Time to discharge from PACU (min)	60 (45-80)	50 (35-60)	0.02*
Median PAED score	3 (1.75-6.25)	4 (2-6)	0.96

*OCR: oculocardiac reflex; IV: intravenous; PACU: post anesthesia care unit; PAED: pediatric anesthesia delirium sore; *P<0.05 (significant)*

Table 4: Details of postoperative vomiting (POV)

POV	Group S *n*=35	Group P *n*=35	*P*
0-24 h (*n*/%)	4 (11.4)	1 (2.9)	0.36
0-2 h	1 (2.9)	0 (0)	0.31
2-6 h	1 (2.9)	0 (0)	0.31
6-24 h	3 (8.6%)	1	0.30
POVOC score			
L	0/4	0/4	NA
H	4/31 (12.9)	1/34 (3.2)	0.4

POVOC: postoperative vomiting in children; L=low risk (POVOC score ≤2); H=high risk (POVOC score >2)

All our patients fell into a high-risk category as they had at least two risk factors for POV in children satisfied by default strabismus surgery, surgery >30 minutes.[9] All of them also received opioids for intraoperative analgesia. Despite this, our incidence of POV is consistent with that reported in literature.[5,18,19] Adequate hydration, avoidance of nitrous oxide, and satisfactory pain relief could have contributed to the low POV but these factors were not objectively assessed in our study.

Oh *et al.* believed attributed the low incidence of POV in their patients to the nature of surgery (recession-resection) and its short duration.[19] The average duration of surgery in our study is longer than that reported in literature.[5,19-21] This is because ours is a teaching institute and squint surgeons are often involved in teaching and training residents in these procedures. This may reflect the scenario in other teaching hospitals as well. Rawlins and Kessell commented that the proficiency of the anesthesiologist and the skill and speed of the surgeon are crucial to reduce POV.[22] Duration of surgery is also a risk factor in the POVOC score.[1] Similar to our finding, few authors have observed that the length of surgery has no influence on the incidence of PONV.[20,23]

On comparing the hemodynamic parameters, the propofol group exhibited higher MAP than sevoflurane group throughout the surgery, postinduction of anesthesia. This could be due to the better hemodynamic stability offered by sevoflurane.[24]

No difference in the incidence of OCR was identified between the propofol and sevoflurane groups in our study. The incidence of OCR in squint surgery under general anesthesia varies from 14%-90%.[25] Other authors have noted higher incidence of OCR in propofol compared to inhalational anesthesia. Occurrence of OCR has also been associated with an increased risk of PONV, although no such relation was identified in our study.[14,20,21,26]

Emergence delirium, although short-lived, is associated with discomfort to the child, need for increased nursing care and parental dissatisfaction.[10] Only three children had PAED score >10 in our study and all belonged to the sevoflurane group. We did not identify any difference in the incidence of ED between the two groups. Children undergoing more complicated strabismus surgery, in terms of longer duration, bilateral surgery, or more muscles had greater incidence of ED.[27] Other authors identified no difference in ED between inhalational and intravenous anesthesia.[21]

The single parameter which showed a significant difference between the two groups was the time to discharge from the PACU which was shorter in the propofol group. Coupled with a low incidence of POV, this may prove advantageous in rapid discharge to home in children operated as a day case.

Limitations

One limitation of our study is the absence of a group where no antiemetic agent was administered, but this would not have been ethically feasible considering the high risk of POV in the absence of prophylaxis. The second is that we did not monitor pain scores postoperatively, although opioids were not used for postoperative analgesia. The third is that depth of sedation was not monitored intraoperatively. Also, nausea was not assessed as it cannot be reliably reported by children aged less than 5 years. Finally, the power of our study may be limited by the lower-than-expected incidence of POV in the sevoflurane group. Future studies in a larger population may help substantiate our results.

Conclusion

Propofol anesthesia for maintenance does not offer advantage over sevoflurane, in reducing postoperative vomiting after squint surgery, when dual prophylaxis with dexamethasone and ondansetron is administered. It, however, reduces the duration of stay in the PACU. There is no difference in the incidence of emergence delirium between the sevoflurane and propofol groups.

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Conflicts of interest

There are no conflicts of interest.

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