Print ISSN: 2321-6379
Online ISSN: 2321-595X

Original Article

Emergence from Anesthesia in Children – A Prospective Comparative Study between Volatile Induction and Maintenance Anesthesia and Total Intravenous Anesthesia

Krishnakant Rawat[1], Sharad Narayan Sharma[1], Gopal Singh Maravi[2], Krishnagopal Rajoriya[3], Ashish Sethi[4], Neeraj Narang[2], Vikesh Agrawal[5]

[1]Senior Resident, Department of Anaesthesiology, Netaji Subhash Chandra Bose Medical College, Jabalpur, Madhya Pradesh, India, [2]Associate Professor, Department of Anaesthesiology, Netaji Subhash Chandra Bose Medical College, Jabalpur, Madhya Pradesh, India, [3]Post Graduation Student, Department of Anaesthesiology, Netaji Subhash Chandra Bose Medical College, Jabalpur, Madhya Pradesh, India, [4]Professor, Department of Anaesthesiology, Netaji Subhash Chandra Bose Medical College, Jabalpur, Madhya Pradesh, India, [5]Professor, Department of Pediatric Surgery, Netaji Subhash Chandra Bose Medical College, Jabalpur, Madhya Pradesh, India

Abstract

Background: Two anesthetic techniques are frequently used in day care surgery, total intravenous anesthesia (TIVA) and volatile induction and maintenance anesthesia (VIMA). They have been extensively used and studied. These mainly involve the induction phase and maintenance phase. The rapid redistribution of intravenous agent could lead to lightening of anesthesia before an adequate depth is achieved with the inhalational agent. This has promoted the rediscovery of single agent anesthesia, which avoid problems related with the transition phase.

Materials and Methods: This randomized controlled trial was conducted in 120 pediatric age group population undergoing inguinal herniotomy under the age group of 2–10 years of the American Society of Anesthesiologists I, II physical status. Patients were randomly divided into two groups of 60 each. Group P received i/v propofol 2–3 mg/kg for induction and 100–400 mcg/kg/min infusion for maintenance. Group S received 8% sevoflurane in 33% of oxygen for induction and 2–3% sevoflurane in 33% oxygen for maintenance. Both the groups received ilioinguinal iliohypogastric block using 0.2% ropivacaine. In both the groups, patients were kept on spontaneous ventilation using Jackson Rees modification of Ayre T piece.

Results: Patients of Group S (VIMA) had early recovery with near-complete achieved modified Aldrete score and pain-discomfort score. Group P patients were relatively calm and less agitated when compared to Group S.

Conclusion: In our study on emergence from anesthesia in children a prospective comparative study between VIMA and TIVA, we found early emergence in VIMA with early cry, early eye opening, and early movement of all four limbs with more incidence of post-operative nausea and vomiting (PONV), while delayed emergence less agitation and no incidence of PONV associated with TIVA with above-mentioned limitations.

Key words: Propofol, Sevoflurane, Total intravenous anesthesia, Volatile induction and maintenance anesthesia

INTRODUCTION

The ideal anesthetic technique for pediatric anesthesia should provide a rapid, smooth induction of anesthesia, stable hemodynamics with superior operating conditions, intraoperative amnesia and analgesia, and prompt awakening at the end of the procedure.[1] In view of this, fast induction and emergence from anesthesia is essential.

Access this article online

www.ijss-sn.com

Month of Submission : 03-2021
Month of Peer Review : 04-2021
Month of Acceptance : 04-2021
Month of Publishing : 05-2021

Two anesthetic techniques are frequently used in day care surgery, total intravenous anesthesia (TIVA) and volatile induction and maintenance anesthesia (VIMA). They have been extensively used and studied. These mainly involve the induction phase and maintenance phase. The rapid redistribution of intravenous (IV) agent could lead

Corresponding Author: Dr. Sharad Narayan Sharma, Department of Anaesthesiology, Netaji Subhash Chandra Bose Medical College, Jabalpur, Madhya Pradesh, India.

to lightening of anesthesia before an adequate depth is achieved with the inhalational agent. This has promoted the rediscovery of single agent anesthesia, which avoid problems related with the transition phase.

We undertook to study the efficacy of these techniques on spontaneously breathing pediatric patients for short duration surgery. Propofol is short-acting general anesthetic agent and is used extensively for TIVA because of its favorable induction properties and quick clearance due to its high metabolic clearance rate. The patient rapidly regains consciousness after discontinuation of the propofol infusion and may be discharged with minimal residual sedation after short outpatient procedure.

VIMA facilitates anesthesia without the need for IV drugs. Sevoflurane is ideal inhalational anesthetic for its properties of being an agent for VIMA leading to faster elimination from body and quicker recovery from anesthesia.[2] These properties make sevoflurane, especially suitable for day surgery in children.

This study was designed to compare emergence and quality of recovery from anesthesia using TIVA with propofol and VIMA with sevoflurane, in children undergoing inguinal herniotomy.

MATERIALS AND METHODS

This study was conducted in the Department of Anaesthesiology in Pediatric Operation Theater at NSCB Medical College and Hospital, Jabalpur. This prospective, randomized, double-blind study included 120 patients of the American Society of Anesthesiologists Grade I and II, age 2–10 years who underwent inguinal herniotomy. Prior ethical permission was taken from our the Institutional Ethical Committee and Review Board and written informed consent was obtained from all parents on behalf of the patients enrolled in the study.

Careful pre-anesthetic evaluation was done and it was made sure that the patients meet the inclusion and exclusion criteria. The patients were randomized on the day of surgery into two groups by sealed envelope method.

Group P allotted 60 patients and 60 patients were allotted in Group S randomly.

- Group P: Group P received propofol 2–3mg/kg IV for induction and 100–400 μg/kg/min IV infusion for maintenance of anesthesia and was oxygenated through face mask using Jackson Rees modification of Ayres T piece. Ilioinguinal and iliohypogastric nerve block was given with 0.2% ropivacaine (0.4 ml/kg) as a measure to achieve post-operative analgesia
- Group S: Group S received inspired concentration (through a facemask) of sevoflurane 8% in 33% oxygen with 66% nitrous oxide for induction and 2–3% of sevoflurane in 33% oxygen with 66% nitrous oxide for maintenance of anesthesia. Ilioinguinal and iliohypogastric nerve block was given with 0.2% ropivacaine (0.4 ml/kg) as a measure to achieve post-operative analgesia.

Jackson Rees modification of Ayre's T-piece circuit was used for the delivery of gases to the patients during anesthesia through facemask. Patients were allowed spontaneous breaths and were adjusted to keep normoxia with oxygen saturation ≥98%.

After the completion of surgical procedure, the propofol infusion and sevoflurane were stopped and 100% oxygen administered.

- The following was recorded by an anesthetist blind to the anesthetic technique used: Time from discontinuation of anesthetic to the movement of the limbs
- Time from discontinuation of anesthetic till the child started crying or was able to state own name
- Recovery characteristics and the quality of emergence was compared using: Modified Aldrete score
- Pain-discomfort scale.

These were recorded by an anesthetist blind to the anesthetic technique, for every 3rd min till 15 min in the recovery.

The "Modified" Aldrete scale

Respiration	2 Able to take deep breath and cough	1 Dyspnea/shallow breathing	0 Apnea
02 saturation	2 Maintains >92% on room air	1 Needs 02 inhalation to maintain 02 saturation >90%	0 Saturation <90% even with supplemental 02
Consciousness	2 Fully awake	1 Arousable on calling	0 Not responding
Circulation	2 BP a 20 mmHg pre-operative	1 BP a 20–50 mmHg pre-operative	0 BP a 50 mmHg pre-operative
Activity	2 Able to move 4 extremities voluntarily or on command	1 Able to move 2 extremities voluntarily or on command	0 Able to move 0 extremities voluntarily or on command

Pain-discomfort scale (FLACC)			
	Scoring		
Items	**0**	**1**	**2**
Blood pressure	>10% of pre-operative level	>20% of pre-operative level	>30% of pre-operative level
Crying	Not crying	Crying but responds to tender loving care	Crying and does not respond to tender loving care
Movement	Mild	Restless	Thrashing
Agitation	None	Patient asleep or calm	Hysterical
Posture	No special posture	Flexing legs and thighs	Holding scrotum or groin
Complaints of pain (When appropriate by age)	Asleep, or states no pain	Cannot localize	Can localize

OBSERVATION AND RESULTS

Values are number (%) of TIVA and VIMA. There were 37 (60%) males in P group while 34 (57.5%) males in S group. Both the groups were comparable in terms of patients demographic data, duration of surgery, and duration of anesthesia [Table 1].

Emergence from anesthesia occurred significantly earlier in the S group as compared to P group as evident by time to eye opening, time to move all four limbs, and time to cry/stating name ($P = 0.0054$) [Table 2].

Similarly, more patients in the S group scored maximum points in the modified Aldrete score at 10 min ($P = 0.0026$) and 20 min ($P = 0.013$) and 30 min ($P = 0.019$) and 40 min ($P = 0.0185$). This study again indicated an early recovery in sevoflurane VIMA group. However, at 50 min ($P = 1$), the difference was insignificant [Table 3].

Similarly, more no. of patients in sevoflurane group scored maximum points in pain-discomfort scale at 10 min ($P = 0.08$), 20 min ($P = 0.223$), and 30 min ($P = 0.006$), while at 40 min onward, none of the patients in either group scored maximum points in the pain-discomfort scale [Tables 3 and 4] [Graphs 1-4].

DISCUSSION

This study was designed to compare emergence and quality of recovery from anesthesia using TIVA with propofol and VIMA with sevoflurane in children undergoing inguinal herniotomy.

In this study, induction with both propofol and sevoflurane was well tolerated. Children in the sevoflurane VIMA group opened their eyes, cry/stating their names, moving all four limbs, interacted with the environment, and scored maximum points on the modified Aldrete scale earlier than in the propofol (TIVA) group.

This study all demographic variables (age, weight and height of patient) and duration of surgery and duration of anesthesia were comparable in both groups with no significant difference. Time of induction in our study was 3.1 ± 1.9 min in Group P and 5 ± 2.3 min in Group S ($P < 0.001$) which is in concordance with the study of Chen *et al.*[3] in which early induction was observed with propofol than sevoflurane which was 34.8 ± 2.4 s in comparison to 81.6 ± 4.7 s, ($P < 0.001$). In concordance with our study, Chen *et al.* also notified more incidence of agitation with sevoflurane in induction and in emergence as well. In our study, agitation was observed in 10 (16.67%) patients in induction phase and in 3 (5%) patients in emergence in Group P. In Group S, agitation was observed in 24 (40%) patients in induction phase and in 33 (55%) patients in emergence. Similarly, in a study of Uezono *et al.*,[4] total incidence of agitation was 38% in sevoflurane group while no agitation was reported in patients using propofol. TIVA consumes lesser time for induction and better stress response which was observed in the form of hemodynamic variables with lesser undesired adverse event. Meanwhile, Guedel second stage of inhalation anesthesia is more apparent in VIMA. Komatsu *et al.* reported electrical seizures in pediatric patient in sevoflurane induction. While using VIMA as induction and maintenance technique, heart rate and mean arterial pressure (MAP) variations were observed in pediatric population age group.[3] Although the same induction and maintenance techniques was employed in adult population, it revealed insignificant variation in heart rate and MAP.[5-7]

Prolong induction in Group S was assumed to be one of cause for agitation. Sevoflurane is pleasant and smooth so preferred as inhaled agent in pediatric group of population. In our study, patients have more anxiety due to separation from parents, intolerance, to NBM duration and restraint with mask while using VIMA method. In Group P, where TIVA method was used, cause of agitation is thought be pain on injection propofol. Unlike to our study in some other, they used IV lignocaine along with propofol which might be a source of error/bias in study. Pre-operative benzodiazepines and other sedatives are recommended to alleviate the agitation in pediatric patient which was not used in our study. In concordance with our study, Welborn *et al.*[8] reported more emergence agitation in sevoflurane anesthesia. In the present study, emergence agitation was significantly higher in Group S, 33 (55%) than Group P which is observed only in 3 patients (5%), it was due to

lesser solubility of sevoflurane which causes early recovery from anesthesia causing anxiety.

Table 1: Demographic data, duration of surgery, and anesthesia

Demographic data	Propofol group (*n*=60)	Sevoflurane group (*n*=60)	*t*-test	*P*-value+
Age (years) (mean±standard deviation)	5.2±2.1	5.8±1.8	1.68	0.095
Weight (kg) (mean±standard deviation)	21.6±6.5	22.2±6.2	1.38	0.06
Height (cm) (mean±standard deviation)	116±22.2	122±24.3	1.41	0.161
Duration of surgery (min) (mean±standard deviation)	36.8±11.5	30±10.1	1.92	0.057
Duration of anesthesia (min) (mean±standard deviation)	42.6±12.8	40.8±9.8	0.86	0.389

Table 2: Induction time, time to spontaneous eye opening, time to move all four limbs, and crying/stating name

Induction and emergence times (min)	P group (*n*=60) Mean±SD	S group (*n*=60) Mean±SD	*P*-value
Induction time	3.1±1.9	5.0±2.3	<0.001
Time to eye opening	9.5±5.1	4.9±2.7	<0.001
Time to move all four limbs	14.2±6.9	11.2±4.8	0.0066
Time to crying/stating name	15.3±7.1	12.1±5.1	0.0054

Similarly, Liao *et al.*[9] concluded early emergence and increased excitement in sevoflurane volatile induction in comparison to propofol/remifentanil i/v anesthesia in foreign body removal in children with $P < 0.05$. Gil *et al.*[10] study was consistent with our study in which rapid emergence was reported with sevoflurane than propofol in pediatric patients in infraumbilical surgeries. Likewise, Ledowski *et al.*[11] stated better inhibition of neuroendocrinal stress in TIVA than sevoflurane. Similar to our study, Hugo *et al.*[12] reported more rapid recovery in prolonged neurological procedures in sevoflurane maintenance anesthesia than propofol, that is, 3 min and 4 min, respectively ($P = 0.01$).

In our study, time to eye opening in Group P was 9.5 ± 5.1 min and 4.9 ± 2.7 min in Group S ($P < 0.001$) which is supported by Pasha *et al.*[13] who reported significantly earlier eye opening in group S than in Group P ($P = 0.043$). Similarly, Viitanen *et al.*[14] also demonstrated early eye opening, early cry/sound in sevoflurane group. In our study, after 20 min of discontinuation of anesthesia, 75% of patients achieved full Aldrete score in sevoflurane group and in 54% in Group P, which is also supported by Viitanen *et al.*[14] who demonstrated that more children acquired full Aldrete score in sevoflurane group than propofol group in the first 20 min after anesthesia ($P < 0.05$). Likely, Pasha *et al.*[13] also concluded similarly that 80% of patients in Group S achieved full Aldrete score in initial 20 min after discontinuation of anesthesia whereas it is achieved in only 57.5% of patients in Group P ($P = 0.03$). Likewise, the study of Maidatsi *et al.*[15] and Peduto *et al.*[16]

Table 3: Number of patients achieving maximum scores after discontinuation of anesthetic drug

Time after discontinuing drugs (min)	Modified Aldrete score full/max (10)						Pain-discomfort scale full/max (10)					
	Propofol (*n*=60)		Sevoflurane (*n*=60)		Z statistics	*P*-value	Propofol (*n*=60)		Sevoflurane (*n*=60)		Z statistics	*P*-value
	n	%24.5	*n*	%			*n*	%	*n*	%		
10	10	17	25	42	3.01	0.02	6	9.8	13	22	1.75	0.22
20	32	54	45	75	2.47	0.03	4	70	8	13	1.22	0.13
30	40	67	51	86	2.35	0.05	0	0	7	12	2.73	0.11
40	47	78	56	94	2.36	0.06	0	0	0	0	1	1
50	60	100	60	100	2.32	1	0	0	0	0	1	1

Table 4: Adverse reactions

Reaction	TIVA (*n*=60)			VIMA (*n*=60)		
	Induction	Maintenance	Emergence	Induction	Maintenance	Emergence
Coughing	0	0	14 (24%)	0	0	24 (40%)
Laryngospasm	0	0	0	0	0	0
Nausea	0	0	0	0	0	0
Vomiting	0	0	0	0	0	2 (3.33%)
Bronchospasm	0	0	0	0	0	0
Agitation	10 (16.67%)	0	3 (5%)	24 (40%)	0	33 (55%)
Other	0	0	0	0	0	0

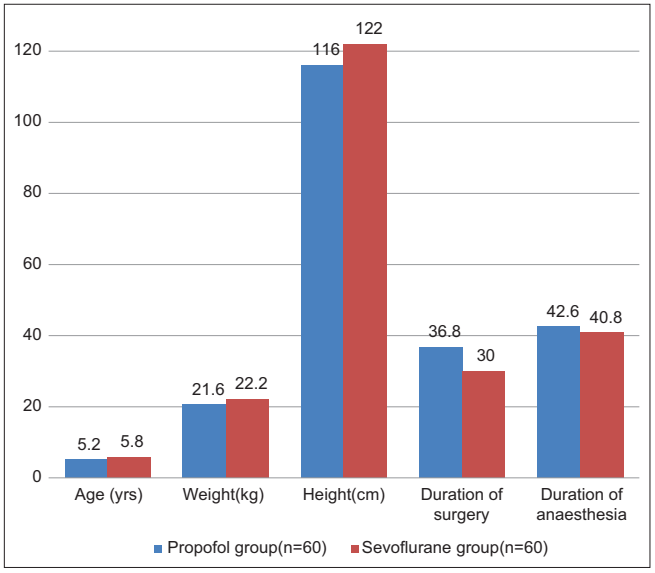
TIVA: Total intravenous anesthesia, VIMA: Volatile induction and maintenance anesthesia

also reported early recovery in sevoflurane anesthesia than propofol with fentanyl anesthesia for day care surgery. In contrast to our study, Magni *et al.*[17] reported no significant difference in emergence time and early cognitive function between sevoflurane/fentanyl and propofol/remifentanil in intracranial surgery. In our study, no incidence of post-operative nausea and vomiting (PONV) was reported in Group P and in Group S only 2 (3.3%) patients reported PONV, which was in concordance with the study of Fredman *et al.*[18] and study of Nathan *et al.*[19] They also reported increased incidence of PONV in sevoflurane anesthesia. PONV is one of the reasons for prolonged stay in recovery, delay discharge, and unanticipated overnight stay in day care surgeries specially in pediatric group of population.[20,21] Early recovery is one of the leading factors associated with good hospital turnover and offers an economic advantage in a day care unit.[22,23] Lesser incidence of PONV in propofol group patients in various studies is due to antiemetic property of propofol. In concordance with our study, Moore *et al.*[24] observed significantly higher nausea in sevoflurane group (11 episodes) and in six patients in propofol with halothane group. In a study of Uezono *et al.*,[4] only 2 cases/(6.25%) episodes of PONV reported in sevoflurane anesthesia in ward which is similar to the present study.

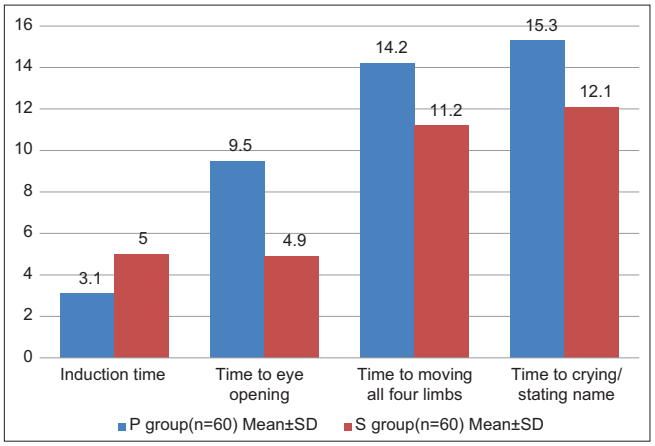
In a study of Pasha *et al.*,[13] higher pain-discomfort score was achieved by patient in sevoflurane group at different time interval after discontinuing the anesthetic agent than propofol group, but it was statistically insignificant. In Viitanen *et al.*[14] study, higher pain-discomfort score was achieved in sevoflurane group at 10 min after discontinuation of anesthesia but it was statistically significant. ($P = 0.04$) but the same was insignificant at interval of 20 min after discontinuation of anesthetic agent. ($P = 0.06$). Although in same study time to emergence, making sound and interaction were earlier in sevoflurane group which is in concordance with our study. Another study by Hugo *et al.*[4] also stated that there were no significant difference in visual analog scale score for the assessment of pain in either group using sevoflurane and propofol. Uezono *et al.*[4] also delivered the same conclusion about the post-operative pain in sevoflurane versus propofol in pediatric population that no additional analgesic required in post-anesthesia care unit (PACU) in either group of patients.

All these studies were similar to our observations in which we observed higher pain-discomfort score in Group S than Group P at 10, 20, and 30 min after discontinuing anesthesia (27.27% vs. 10%), (13.3% vs. 6.66%), and (12% vs. 0%), respectively, but all these were statistically insignificant with $P > 0.05$. Modified Aldrete scoring system and pain-discomfort score both were used to assess the recovery from anesthesia and quality of emergence by Hanallah *et al.*[24]

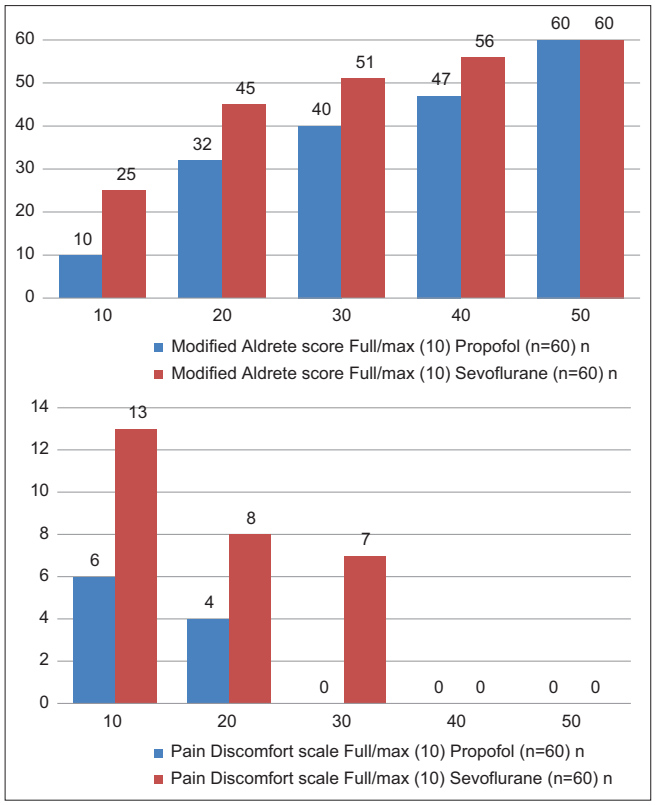
In the present study, time to spontaneous eye opening after discontinuation of anesthesia in Group P and Group S was 9.5 ± 5.1 min and 4.9 ± 2.7 min, respectively ($P < 0.001$), which was similar to the study of Uezono *et al.*[4] who observed significantly early eye opening in sevoflurane group at 19 ± 8 min than propofol group at 32 ± 16 min ($P < 0.05$). Similarly, early eye opening was there in a study by Hugo *et al.*[12] ($P < 0.001$). Likewise, Pasha *et al.*[13] also witnessed the same in their study, in which early eye opening was there in sevoflurane group at 4.7 ± 2.6 min and at 8.3 ± 6.9 min in propofol group ($P = 0.017$). In same study, time to cry/stating the name was also earlier in sevoflurane group at 11.3 ± 4.6 min than propofol group at 14.7 ± 7.2 min ($P = 0.039$) which is in concordance with the present study. In our



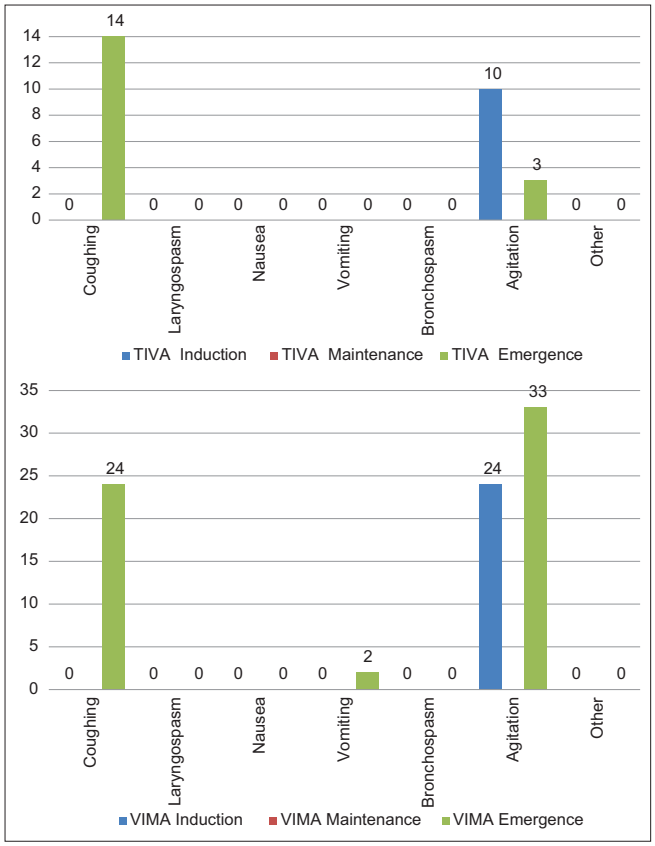
Graph 1: Demographic data, duration of surgery, and anesthesia



Graph 2: Induction time, time to spontaneous eye opening, time to move all four limbs, and crying/stating name



Graph 3: Number of patients achieving maximum scores after discontinuation of anesthetic drug



Graph 4: Adverse reactions

study, time to cry/stating the name in Group P patient was 15.3 ± 7.1 min and it was 12.1 ± 5.1 min Group S patients ($P = 0.005$). In a study of Viitanen *et al.*,[14] early recovery variables were observed in sevoflurane patients, in which making sound was noticed in sevoflurane group at 10 ± 4 min and at 15 ± 7 min in propofol group ($P = 0.002$), although early recovery using different variables was observed in our study in Group S patients but in other studies such as Aono *et al.*[25] and O'Kelly *et al.*[26] showed greater incidence of emergence delirium during recovery from sevoflurane anesthesia in preschool population. Sevoflurane anesthesia in preschool population, which may be due to the age effect of the studied population and unfamiliar surroundings. Westrin *et al.*[27] also found that post-anesthetic agitation was related to age of children and not to the perception of pain. It had been also suggested by O'Kelly *et al.*,[26] shorter time to emergence may contribute to post-operative delirium.

Many studies had notice early recovery in sevoflurane anesthesia predominantly in day care anesthesia.[28] Even in prolonged duration of anesthesia in neurological procedures, same was observed by Hugo *et al.*[12]

In our study, other adverse events as laryngospasm and coughing were not observed either at induction or emergence in both groups. Emergence agitation may lead to threaten complication such as inadvertent movement, falling from operation table, and accidental removal of drain catheter or i/v cannula or self-injury, so while dealing with preschool population in operation rooms, it is necessary for anesthesiologist, surgeons, and other care providers to keep continuous and intensive alertness. Comparison of inhaled and i.v anesthetic in such scenario is much complicated. In our study, clinical crude variables were used for the assessment of emergence agitation, no monitoring of depth of anesthesia using BIS devise or other was there. For pain, ilioinguinal iliohypogastric block was given by surgeon using 0.2% ropivacaine (0.4 ml/kg) immediately after induction with land mark technique. Authenticity of all these methods is not so much reliable, so all these were limitation of our study because depth of anesthesia and pain stimulus may be contributor to emergence agitation.

Despite early emergence in Group S patients leading good case turn over, minimum stay in PACU, and other economical benefits, it failed to gain parent satisfaction. Because this is not surprising, maximum parents are unaware of duration of PACU stay, if they were allowed to be in PACU, no one like to see his/her child to be agitated. Instead a slower but smoother course of recovery after propofol anesthesia is more appealing to parents. PONV was also more associated with sevoflurane anesthesia.

CONCLUSION

In our study on emergence from anesthesia in children a prospective comparative study between VIMA and TIVA, we found early emergence in VIMA with early cry, early eye opening, and early movement of all four limbs with more incidence of PONV, while delayed emergence less agitation and no incidence of PONV associated with TIVA with above-mentioned limitations. There is more to explore in this scenario, especially in pediatric group of population.

REFERENCES

1. Rawal N. Post discharge complications and rehabilitation after ambulatory surgery. Curr Opin Anaesthesiol 2008;21:736-42.
2. Maidatsi PG, Zaralidou T, Gorgias NK. Rocuronium duration of action under sevoflurane, desflurane and propofol anaesthesia. Eur J Anaesthesiol 2004;21:781-6.
3. Chen L, Yu L, Fan Y, Manyande A. A comparison between total intravenous anaesthesia using propofol plus remifentanil and volatile induction/maintenance of anaesthesia using sevoflurane in children undergoing flexible fibreoptic bronchoscopy. Anaesth Intensive Care 2013;41:742-9.
4. Uezono S, Goto T, Terui K, Ichinose F, Ishguro Y, Nakata Y, Morita S. Emergence agitation after sevoflurane versus propofol in pediatric patients. Anesth Analg 2000;91:563-6.
5. Kim YH, Yoon SZ, Lim HJ, Yoon SM. Prophylactic use of midazolam or propofol at the end of surgery may reduce the incidence of emergence agitation after sevoflurane anaesthesia. Anaesth Intensive Care 2011;39:904-8.
6. Ebert TJ. Cardiovascular and autonomic effects of sevoflurane. Acta Anaesthesiol Belg 1996;47:15-21.
7. Constant I, Dubois MC, Piat V, Moutard ML, McCue M, Murat I. Changes in electroencephalogram and autonomic cardiovascular activity during induction of anesthesia with sevoflurane compared with halothane in children of anesthesia with sevoflurane compared with halothane in children. Anesthesiology 1999;91:1604-15.
8. Welborn LG, Hannallah RS, Norden JM, Ruttimann UE, Callan CM. Comparison of emergence and recovery characteristics of sevoflurane, desflurane, and halothane in pediatric ambulatory patients. Anesth Analg 1996;83:917-20.
9. Liao R, Li JY, Liu GY. Comparison of sevoflurane volatile induction/maintenance anaesthesia and propofol-remifentanil total intravenous anaesthesia for rigid bronchoscopy under spontaneous breathing for tracheal/bronchial foreign body removal in children. Eur J Anaesthesiol 2010;27:930-4.
10. Gil ML, Brimacombe J, Clar B. Sevoflurane versus propofol for induction and maintenance of anaesthesia with the laryngeal mask airway in children. Paediatr Anaesth 1999;9:485-90.
11. Ledowski T, Bein B, Hanss R, Paris A, Fudickar W, Scholz J, *et al*. Neuroendocrine stress response and heart rate variability: A comparison of total intravenous versus balanced anesthesia. Anesth Analg 2005;101:1700-5.
12. Castagnini HE, van Eijs F, Salevsky FC, Nathanson MH. Sevoflurane for interventional neuroradiology procedures is associated with more rapid early recovery than propofol. Can J Anaesth 2004;51:486-91.
13. Pasha AK, Kazi WA, Farhat K, Khan RA. Emergence from anesthesia in children undergoing ambulatory surgery a comparison between propofol and sevoflurane using single anesthetic technique. Pak Armed Forces Med J 2013;63:109-13.
14. Viitanen H, Tarkkila P, Mennander S, Viitanen M, Annila P. Sevoflurane-maintained anesthesia induced with propofol or sevoflurane in small children: Induction and recovery characteristics. Can J Anaesth 1999;46:21-8.
15. Maidatsi PG, Zaralidou AT, Gorgias NK, Amaniti EN, Karakoulas KA, Giala MM. Rocuronium duration of action under sevoflurane, desflurane or propofol anaesthesia. Eur J Anaesthesiol 2004;21:781-6.
16. Peduto VA, Mezzetti D, Properzi M, Giorgini C. Sevoflurane provides better recovery than propofol plus fentanyl in anaesthesia for day-care surgery. Eur J Anaesthesiol 2000;17:138-43.
17. Magni G, Baisi F, Rosa LI, Imperiale C, Fabbrini V, Pennacchiotti ML, *et al*. No difference in emergence time and early cognitive function between sevoflurane-fentanyl and propofol-remifentanil in patients undergoing craniotomy for supratentorial intracranial surgery. J Neurosurg Anesthesiol 2005;17:134-8.
18. Fredman B, Nathanson MH, Smith I, Wang J, Klein K, White PF. Sevoflurane for outpatient anesthesia: A comparison with propofol. Anesth Analg 1995;81:823-8.
19. Nathan N, Peyclit A, Lahrimi A, Feiss P. Comparison of sevoflurane and propofol for ambulatory anaesthesia in gynaecological surgery. Can J Anaesth 1998;45:1148-50.
20. Fisher DM. Surrogate end points: Are they meaningful? Anesthesiology 1994;81:795-6.
21. Splinter WM, Roberts DJ, Rhine EJ, Komocar L. Nitrous oxidedoes not increase vomiting in children after myringotomy. Can J Anaesth 1995;42:274-6.
22. Moore EW, Pollard BJ, Elliott RA. Anaesthetic agents in paediatric day case surgery: Do they affect outcome? Eur J Anaesthesiol 2002;19:9-17.
23. Dexter F, Coffin S, Tinker JH. Decreases in anesthesia-controlled time cannot permit one additional surgical operation to be reliably scheduled during the workday. Anesth Analg 1995;81:1263-8.
24. Moore JK, Moore EW, Elliott RA, St Leger AS, Payne K, Kerr J. Propofol and halothane versus sevoflurane in paediatric day-case surgery: Induction and recovery characteristics: Br J Anaesth 2003;90:461-6.
25. Aono J, Ueda W, Mamiya K, Takimoto E, Manabe M. Greater incidence of delirium during recovery from sevoflurane anesthesia in preschool boys. Anesthesiology 1997;87:1298-300.
26. O'Kelly SW, Voepel-Lewis T, Tait AR. Postoperative behavior and emergence delirium in pediatric patients: A prospective study. Anesthesiology 1997;87:A1060.
27. Westrin P, Beskow A. Sevoflurane causes more postoperative agitation in children than does halothane. Anesthesiology 1997;87:A1061.
28. Robinson BJ, Uhrich TD, Ebert TJ. A review of recovery from sevoflurane anaesthesia: Comparisons with isoflurane and propofol including meta-analysis. Acta Anaesthesiol Scand 1999;43:185-90.

How to cite this article: Rawat K, Sharma SN, Maravi GS, Rajoriya K, Sethi A, Narang N, Agrawal V. Emergence from Anesthesia in Children – A Prospective Comparative Study between Volatile Induction and Maintenance Anesthesia and Total Intravenous Anesthesia. Int J Sci Stud 2021;9(2):43-49.

Source of Support: Nil, **Conflicts of Interest:** None declared.