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Comparing the recovery characteristics between sevoflurane and isoflurane following removal of laryngeal mask airway under deeper planes of anesthesia in pediatric surgical patients: An observational study

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ABSTRACT

Background: Respiratory complications during emergence from general anesthesia present serious concerns in pediatric patients. Deep extubation excludes airway stimulation under lighter planes of anesthesia, but renders the patient with an unprotected airway susceptible to aspiration and obstruction. It is therefore desirable to prefer an anesthetic technique that would reduce the time interval between removal of airway device and patient awakening. **Aims and Objectives**: The aim of this study was to compare the effects of isoflurane and sevoflurane on emergence characteristics under deeper planes of anesthesia in pediatric surgical patients. **Materials and Methods:** Ninety-two pediatric patients stationed for lower abdominal surgeries were assigned into Group I, 45 patients (isoflurane) and Group II, 47 patients (sevoflurane). The patients were observed during recovery from anesthesia and various parameters recorded. **Results:** Patients in Group II attained spontaneous movement earlier than Group I; (6.33 ± 1.45 min vs. 9.01 ± 1.37 min [P < 0.05]), timing of shifting from the operating room to recovery and spontaneous eye opening was significantly shorter in Group II than in Group I; (8.63 ± 1.51 min vs. 11.76 ± 1.22 min [P < 0.05]) and (10.25 ± 1.52 min vs. 13.29 ± 1.22 min [P < 0.05]), respectively. However, the actual discharge readiness and time of shifting from recovery room was similar for both Group I and Group II [35.35 ± 2.50 min vs. 34.46 ± 2.41 min [P > 0.05]). **Conclusion:** Laryngeal mask airway removal under deep sevoflurane anesthesia leads to early attainment of an arousable state and return of protective airway reflexes.

Key words: Pediatric anesthesia; Deep extubation; Awake extubation; Sevoflurane; Isoflurane; Airway complications

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INTRODUCTION

Administration of general anesthesia requires the maintenance of a patent airway, using an airway device, such as an endotracheal tube or a laryngeal mask airway (LMA).[1,2] These devices are removed at the termination of general anesthesia. However, in context of pediatric patients, it has been observed that airway complications are most frequent during this phase, due to airway manipulation in lighter planes of anesthesia.[3,4]

The removal of airway devices can be performed in one of the two ways: When patients are still in a deep anaesthetized state (deep extubation), or in a conscious

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and awake state (awake extubation). However, the optimal timing for extubation in pediatric patients is a subject matter of ongoing debate. Tracheal extubation during deep anesthesia entails removing the airway device during the surgical stage of general anesthesia while the patient is breathing spontaneously but the airway reflexes are still depressed. Extubation under deeper planes of anesthesia offers definitive advantage of preventing upper airway stimulation during airway manipulation.[5,6] This technique may provide a smoother emergence from anesthesia, with a lower likelihood of bronchospasm, coughing and other respiratory issues which are common in pediatric patients during extubation. Several studies have demonstrated significantly lower episodes of desaturation with deep extubation.[7]

General anesthesia depresses the airway reflexes; hence, extubation in deeper anesthetic planes may render the patient with an unprotected airway susceptible to aspiration; additionally, an unsecured airway if not properly handled may become obstructed, leading to hypoxia and hypercapnia. Therefore, it seems desirable that after deep extubation, the intervening interval from removal of the airway devices to return of airway reflexes should be very small. Isoflurane is the most commonly used volatile anesthetic; however, it is known to cause airway irritation and its use during induction of anesthesia has been associated with higher incidence of breath holding, coughing, and airway obstruction.[8,9] On the other hand, sevoflurane is easily tolerated for inhalational induction of anesthesia and has a relatively low blood: Gas partition coefficient, leading us to expect a rapid recovery and smooth emergence with sevoflurane after deep extubation than isoflurane.[10,11] The existing literature is limited and not very decisive regarding the preferred mode of extubation technique and proper choice of inhalational agent that would offer a definitive advantage of an early recovery together with a relatively better safety profile in pediatric age group.

Aims and objectives

To compare the effects of isoflurane and sevoflurane on emergence characteristics under deeper planes of anesthesia in pediatric surgical patients.

MATERIALS AND METHODS

This prospective, observational study was conducted in the Department of Anesthesiology at Government Medical College, Srinagar and associated hospitals. The study included 92 pediatric patients between 5 months and 8 years of age, American Society of Anesthesiologists (ASA) Classes I and II, scheduled for lower abdominal surgeries below the level of umbilicus. Written informed consent was obtained from the parents and the study was conducted after obtaining ethical clearance from the Institutional Ethics Committee.

Based on a rather conservative estimate from Valley et al.,[12] it was determined that at least, 45 patients would be required in each group to demonstrate a significant difference at the 0.05 significance level with a power of 0.8 and an effect size of 0.603. The study subjects were divided into two groups, Group I (isoflurane) with 45 patients and Group II (sevoflurane) with 47 patients.

Inclusion criteria

The inclusion criteria were as follows: Pediatric patients of age 5 months–8 years, ASA Classes I and II, scheduled for elective lower abdominal surgeries were enrolled for this study.

Exclusion criteria

The exclusion criteria were as follows: Patients whose parents refused to consent for the study, those with anticipated difficult airway or a history of recent respiratory tract infection, ASA Class ≥III, were excluded from the study. Patients with known allergies to any of the anesthetic drugs were also excluded from the study. In addition, two patients from Group I who had a significant leak with LMA, and had to be intubated, were also excluded from the study.

All the patients were allowed a fasting interval of at least 6 h before induction. Anesthesia was standardized for all the study subjects. Patients were induced with intravenous (IV) fentanyl 1 μg/kg and propofol 2 mg/kg, muscle relaxation was accomplished with IV atracurium 0.5 mg/kg, and anesthesia was maintained with a mixture of oxygen, nitrous oxide, and volatile agent, IV dexamethasone 0.1 mg/kg was administered for prophylaxis against post-operative vomiting, and analgesia was augmented using caudal anesthesia in all the patients. The study subjects were allocated to either group depending on the volatile anesthetic used.

- Group I: Anesthesia maintained with isoflurane.
- Group II: Anesthesia maintained with sevoflurane.

Intraoperatively, besides routine hemodynamic monitoring (Heart rate, blood pressure, and saturation), concentration of exhaled inhalational anesthetics and end-tidal carbon dioxide were also monitored throughout the conduct of anesthesia. Toward the last 20 min of the procedure, the residual neuromuscular blockade was reversed using neostigmine 50 μg/kg and glycopyrrolate 10 μg/kg IV, and the child was allowed to breathe spontaneously. The inhaled anesthetics were adjusted to 1.5 Minimum Alveolar Concentration and nitrous oxide was discontinued. At

the commencement of surgery, the LMA was removed and oropharynx was suctioned for the presence of any secretions. Airway was maintained open using appropriate maneuvers and oxygen was given through face mask. Once it was established that the child was able to maintain an adequate airway, they were shifted to post anesthesia care unit (PACU) and were monitored till fully awake. During the recovery phase in PACU, supplemental oxygen was provided using a facemask.

The child was observed for the need of any airway support and the occurrence of airway events (excessive secretions, breath-holding, coughing, and laryngospasm). Oxygen saturation was continuously monitored and documented. Consciousness was continuously monitored until the patient was fully awake and ready to be shifted from recovery unit. Time from removal of LMA to spontaneous eye opening, time to meeting standard discharge criteria, and the actual time to discharge from PACU were noted. In addition, occurrence of emergence delirium, need for additional analgesic, and post-operative vomiting were also documented.

The recorded data were compiled and entered in a spreadsheet (Microsoft Excel) and then exported to data editor of Statistical Package for the Social Sciences (SPSS) Version 20.0 (SPSS Inc., Chicago, Illinois, USA). Continuous variables were expressed as Mean±SD and categorical variables were summarized as frequencies and percentages. The Shapiro–Wilk test was applied to test the normality of data. Student's independent t-test or Mann–Whitney U-test, whichever feasible, was employed for comparing continuous variables. Chi-square test or Fisher's exact test, whichever appropriate, was applied for comparing categorical variables. $P<0.05$ was considered statistically significant.

RESULTS

Table 1 represents the baseline characteristics of the study population, the baseline characters were comparable between the two groups ($P>0.05$).

Table 2 represents the parameters recorded during emergence of the patients from anesthesia, the times being measured from the instant when LMA was removed, saturation was measured on supplemental oxygenation and was similar between two groups, patients receiving sevoflurane for maintenance recovered early compared to those receiving isoflurane; however, the actual discharge readiness from PACU was similar in both the groups.

Table 3 shows that no major complications were noted in either of the two groups during emergence from deep anesthesia; however, two patients in isoflurane group had breath holding spells which were easily relieved by applying positive end-expiratory pressure (PEEP) and five patients from sevoflurane group developed emergence delirium characterized by inconsolable agitation despite adequate analgesia.

DISCUSSION

Emergence from anesthesia represents a transition from an unconscious state to a completely awake state and recovery, and it is considered to be one of the most arduous phases of anesthetic care.[13-15] This period is particularly demanding in case of pediatric patients raising concerns regarding the optimal technique to prevent the occurrence of adverse airway events in this age group. Airway devices used during general anesthesia are commonly removed either awake or under deeper anesthetic planes, and both are standard practices with their own merits and demerits.[16-19]

Deep extubation in children is considered an appropriate technique to prevent issues related to airway manipulation under lighter anesthesia, it is also helpful to manage reactive airways which are very common in pediatric age group, and has also been used by many practitioners as a means to prevent emergence agitation, with varying results.[17,20] However, it renders the airway unprotected from potential hazards of aspiration of secretions and obstruction, during the intervening period from removal of airway device to return of consciousness; therefore, selection of an anesthetic that would limit this duration would be desirable for a deep extubation.

The baseline characteristics of both the groups were similar, a total of 92 pediatric patients posted for below umbilicus lower abdominal surgeries, of age group 5 months–8 years, distributed between two groups with 45 patients in Group I and 47 patients in Group II. A similar study population was chosen by Valley et al., who studied the recovery characteristics after tracheal extubation of deeply anesthetized pediatric patients using desflurane and sevoflurane.[12]

It was observed from our study that both isoflurane and sevoflurane can be safely used for removal of airway device under deep anesthesia. Patients in whom the LMA was removed under sevoflurane anesthesia reached an arousable state earlier than those who were breathing isoflurane. This observation may be attributed to different blood-gas partition coefficients for sevoflurane (0.65) versus isoflurane (1.4); hence, a more rapid emergence would be expected for sevoflurane.[11] However, this demarcation in

Table 1: Demographic characteristics

Parameter	Group I (isoflurane)	Group II (sevoflurane)	P-value
Number of patients (n)*	45	47	>0.05
Age mean±SD (range)	3.4±2.3 years (6 months–8 years)	3.6±2.5 years (5 months–8 years)	>0.05
Weight (kg) mean±SD (range)	13.7±4.3 kg (7 kg–20 kg)	13.9±4.5 (6.5 kg–21 kg)	>0.05
Gender (M/F) n (%)	40/5 (89/11)	38/9 (81/19)	>0.05
ASA status** I/II (n)	45/0	47/0	>0.05
Duration of surgery mean±SD (range)	92±16 min (68–125)	90±17 min (65–120)	>0.05

*n: Number of patients. **ASA: American society of anesthesiologists

Table 2: Emergence from anesthesia

Parameter	Group I (isoflurane)	Group II (sevoflurane)	P-value
SpO_2* mean±SD (range)%	98.91±0.73 (98–100)	99.09±0.78 (98-100)	>0.05
Spontaneous movement with maintained airway mean±SD (range) min	9.01±1.37 (6.6–11.7)	6.33±1.45 (4.2–9.1)	<0.05
Shifting from OR** mean±SD (range) min	11.76±1.22 (8.4–13.3)	8.63±1.51 (6.1–11.4)	<0.05
Spontaneous eye opening mean±SD (range) min	13.29±1.22 (9.2–14.6)	10.25±1.52 (7.3–12.5)	<0.05
PACU*** discharge mean±SD (range) min	35.35±2.50 (30–40.5)	34.46±2.41 (25–38)	>0.05

*SpO_2: Peripheral oxygen saturation. **Operating room. ***Post-anesthesia care unitPACU: Post anesthesia care unit, OR: Odds ratio

Table 3: Complications during emergence

Complication	Group I	Group II	P-value
Breath holding (n)	2	---	
Coughing (n)	---	---	---
Laryngospasm (n)	---	---	---
Desaturation (n)	---	---	---
Emergence delirium (n)	---	5	
Post-operative vomiting (n)	---	---	---

n: Number of patients

recovery faded later during the recovery period, and the time for actual discharge from the PACU was similar for both the groups. These findings might be explained by the greater effect of blood-tissue gradients on elimination during the later stages of recovery as against the effect of differences in blood-gas partition coefficients which are more pronounced during the early recovery phase, due to a larger alveolar-blood gradient facilitating early recovery. The brain-blood partition coefficients for isoflurane (1.6) and sevoflurane (1.7) being almost similar. Thus, any difference in recovery times would be expected to be greatest during measures of early recovery.[11,21-23]

We observed, that two patients in Group I (isoflurane) developed breath-holding and no patient in either groups had coughing, laryngospasm, or episodes of desaturation during recovery from deeper anesthesia. A study by Doi and Kazuyuki[24] found that sevoflurane did not elicit any coughing response compared with isoflurane, halothane, and enflurane. Our observation for adverse events during recovery phase suggests that, the reported increase in airway irritability seen with isoflurane may be more pronounced and problematic during induction than on emergence.[25,26] Desflurane being another pungent and irritant inhalational agent does not pose any serious issues of increased irritability during recovery either, as has been seen in many studies.[6,22,27] Emergence agitation was observed in five patients from the sevoflurane group and none of the patients from isoflurane group had emergence delirium or agitation during recovery phase. Several studies already establish a higher incidence of post-operative emergence delirium with sevoflurane anesthesia[28,29] and the present study is in agreement to these studies; however, differentiating delirium from a temper tantrum can be difficult in this age group of patients. Nevertheless, certain other studies show that there is no difference in the incidence of emergence delirium with isoflurane and sevoflurane in pediatric patients, and further studies might be needed to explore this aspect further.[30]

From our study, we found that removal of LMA can be safely done in deep anesthetic planes in pediatric age group with either isoflurane or sevoflurane, ensuring an adequate analgesia and holding the airway using appropriate maneuvers to prevent obstruction. Patients in whom sevoflurane was used reached an arousable state earlier than isoflurane group, underscoring the additional safety for a deeper extubation, as protective airway reflexes resumed earlier in this patient group, and they were less susceptible to develop breath holding spells; however, time to discharge from recovery area was same for both the groups. The occurrence of emergence delirium was observed in patients receiving sevoflurane; however, this observation was statistically non-significant.

Limitations of the study

1. This study was observational in nature
2. The study was done on patients undergoing below umbilical surgeries only, inclusion of other surgical procedures might have led to a more comprehensive data.

CONCLUSION

LMA removal under deep anesthetic planes using sevoflurane offers some degree of advantage over isoflurane in pediatric patients, as its use leads to early attainment of an arousable state and return of protective airway reflexes.

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