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Comparison of different induction techniques on hemodynamic changes in pediatric patients undergoing infra umbilical surgeries using laryngeal mask airway

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ABSTRACT

Background: Post-induction hypotension associated with various agents is well-known in adults undergoing general anesthesia for various procedures. However, this phenomenon has not been addressed well in pediatric patients. We studied the incidence of post-induction hypotension in patients 1–5 years using inhalational induction with sevoflurane, intravenous induction with propofol, and co-induction with sevoflurane plus propofol. **Aims and Objectives:** To compare three different induction techniques in children 1–5 years undergoing various infra-umbilical surgeries under general anesthesia with laryngeal mask airway using sevoflurane induction, propofol induction, and sevoflurane plus propofol co-induction. **Materials and Methods:** Out of 150 patients observed in this study, 50 patients (group S) received inhalational induction with sevoflurane, 50 (group P) patients received intravenous induction with propofol, and 50 (group SP) patients received co-induction with propofol and sevoflurane. **Results:** Intravenous induction with propofol resulted in maximum hemodynamic changes Inhalational induction was responsible for significant changes in heart rate whereas co-induction with propofol (1–1.5 mg/kg) and sevoflurane 5% yielded minimum hemodynamic variations with least adverse effects. **Conclusion:** We conclude that co-induction with propofol (1–1.5 mg/kg) plus Sevoflurane 5% provided better hemodynamic stability with the least adverse effects.

Key words: General anesthesia; Proseal laryngeal mask airway; Propofol; Sevoflurane

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INTRODUCTION

Induction of anesthesia is frequently associated with changes in heart rate and blood pressure. Post-induction hypotension associated with various agents is well-known in adults undergoing general anesthesia for various procedures. However, this phenomenon has not been addressed well in pediatric patients. Various induction techniques practiced in pediatric patients undergoing general anesthesia for different procedures include intravenous induction using various intravenous induction agents, inhalational induction using inhalational agents, and co-induction using a combination of both.

Intravenous induction is preferred in patients at risk of malignant hyperthermia, in neurosurgical patients where intracranial pressure and cerebral metabolic rate need tight control, and in patients who are at high risk for post-operative nausea and vomiting. Some of the common drugs given in intravenous anesthesia include propofol, etomidate, opioids, and dexmedetomidine.[1] Propofol is accepted as the most frequently administered medication

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for laryngeal mask airway (LMA) insertion.[2,3] Awakening is more rapid and complete than after induction of anesthesia with all other drugs used for rapid i.v. induction of anesthesia.[4] Besides being an induction agent, propofol has antiemetic, antipruritic, and anticonvulsant activity.[5]

Propofol is the most commonly used intravenous induction agent, whereas sevoflurane is the most common inhalational agent used for induction in small children. Most of the infraumbilical procedures in pediatric patients are done under general anesthesia using LMA. It is a safe, simple, well-tolerated, reusable, and cost-effective method for airway management in both neonatal and pediatric patients. It minimizes stress response and airway resistance.[6]

Inhalational induction proves to be less traumatic, especially in children, in patients who have needle phobia, and in patients with cognitive disabilities. Inhalational induction is also preferred, wherein cannulation is difficult. Maintaining airway tone, altering anesthesia depth with ease and bronchodilatation are some other advantages of inhalational induction.[7] Commonly used inhalational agents for anesthetic induction include sevoflurane. The use of desflurane and isoflurane diminished due to airway irritability and associated breath-holding and laryngospasm. Sevoflurane with low blood gas solubility (0.69) allows rapid induction and early emergence. Sevoflurane is most suited for inhalational induction. Sevoflurane is superior to other anesthetic regimens in preserving cardiac output and contractility and maintaining normal blood pressure.[7-9]

Co-induction refers to the administration of a small dose of intravenous induction agent in combination with an inhalational agent to reduce the dose of induction agents and to achieve a more specific response while minimizing side effects. The objective of this technique is to improve the ratio of desired versus adverse effects and to reduce the cost.[10]

Supraglottic airway devices have been increasingly used in recent years in children.[11] Second-generation supraglottic devices, with gastric channels, are preferred in abdominal procedures.[12]

There is no consensus on what constitutes intraoperative hypotension in pediatric population and most of the pediatric anesthesiologists define intraoperative hypotension as a 20–30% fall in blood pressure below the baseline.[13,14]

Thus, the present study was done to compare the incidence of hypotension between inhalational induction with sevoflurane, intravenous induction with propofol, and co-induction with sevoflurane plus propofol. The ease of induction, intraoperative hemodynamics, and side effects associated with different induction techniques were compared in kids between 1 and 5 years.

Aims and objectives

To compare the effects of various induction techniques on hemodynamics in pediatric patients.

MATERIALS AND METHODS

This prospective observational was conducted at Sher-i-Kashmir Institute of Medical Sciences, Srinagar, from December 2019 to June 2021, after obtaining ethical clearance from the SKIMS ethics committee (SIMS1 31/IEC-SKIMS/2021-159). The study was carried out on 150 ASA I and II, pediatric patients of either sex between 1 and 5 years of age, who underwent various infraumbilical operations under general anesthesia using LMA. Patients with difficult airways and known allergies to the study drug were excluded. A written informed consent was obtained from the patient family.

Patients were prepared by overnight fasting (6 h for solids and 2 h for clear liquids) and were given an intravenous solution of midazolam (0.5 mg/kg) combined with honey, orally as pre-medication 1 h before the procedure in the holding area. Patients were divided into three groups.

- Group S – The patients in this group received inhalational induction with sevoflurane (8%) using tidal volume breathing technique
- Group P – The patients in this group received intravenous induction with propofol (2–2.5 mg/kg)
- Group SP – The patients in this group received intravenous propofol (1–1.5 mg/kg) along with inhalational agent sevoflurane (5%).

All the patients came with an intravenous line from the pediatric unit as per the hospital protocol. Routine monitors were attached (non-invasive blood pressure, oxygen saturation [SpO_2], and electrocardiogram). All the baseline parameters, i.e., heart rate, blood pressure (systolic, diastolic, and mean arterial pressure), and SpO_2 were recorded. The technique of anesthesia was standardized for all the patients in the study and LMA was introduced when there was no response to jaw stimulation during mask ventilation. All the patients received caudal epidural following induction and LMA insertion, in lateral position with ropivacaine 0.2% at 1 mL/kg for analgesia. At induction and 1 min, 3 min, 5 min, and 10 min after LMA insertion, hemodynamic parameters, i.e., heart rate, blood pressure, SpO_2, and any other complications, such as arrhythmia, hypotension, and bronchospasm, were recorded. Anesthesia was maintained with isoflurane (1 MAC), oxygen, and nitrous

oxide. Patients breathed spontaneously and were assisted when needed at the beginning of the procedure. All the patients received intravenous paracetamol at 10 mg/kg for supplemental analgesia and ondansetron 0.1 mg/kg with dexamethasone 0.1 mg/kg for post-operative nausea and vomiting. LMA was removed at the end of the procedure. All the patients were observed in the post-anesthetic care unit for 1 h and discharged when they got awake and alert (with a modified Aldrete score between 9 and 10).

Statistical method

The presentation of the categorical variables was done in the form of numbers and percentages (%). On the other hand, the presentation of the continuous variables was done as mean±standard deviation. The following statistical tests were applied to the results:

1. The comparison of the variables which were quantitative in nature were analyzed using an independent t-test
2. The comparison of the variables which were qualitative in nature were analyzed using the Chi-square test.

The data entry was done in the Microsoft Excel spreadsheet and the final analysis was done with the use of Statistical Package for Social Sciences software version 21.0.

The actual sample size remained 150 patients at having 95% power of study at 95% confidence interval with a margin of error 1%. All values were discussed at 5% level of significance, i.e., (P<0.05).

RESULTS

The demographic variables in all three groups are comparable except that males are predominant in all three groups (Table 1). When we compared SpO_2 in three groups, no significant drop in saturation was observed in any group (Figure 1). When we compared heart rates in three groups, we observed a drop-in heart rate from baseline (99 ± 4 bpm) to 10 min post-induction (84±19 bpm) in group P. Similarly, we observed a drop-in heart rate from baseline (100±9 bpm) to 10 min post-induction (72±17 bpm) in group S. In group SP, no significant decrease in heart rate was found. When a comparison was made between group P versus group S, the decrease in heart rate was statistically significant at 1 min, 3 min, 5 min, and 10 min. When a comparison was made between group P versus group SP, the decrease in heart rate was statistically significant at baseline, at induction, at 3 min, 5 min, and 10 min. Between group S versus group SP, the decrease in heart rate was statistically significant at 1 min, 3 min, 5 min, and 10 min (Table 2). When we compared systolic blood pressure in three groups, we observed a drop of 20 mmHg from baseline (98±6 mmHg) to 10 min post-induction (78±14 mmHg) in group P. In group S and SP, no significant drop in systolic blood pressure was observed. When a comparison was made between group P versus group S, we observed a statistically significant difference at 1 min, 3 min, 5 min, and 10 min post-induction. Between group P versus group SP, we observed a statistically significant difference at 1 min, at min, 5 min, and 10 min between group S versus group SP, no significant difference was observed (Table 3). When we compared diastolic blood pressure in three groups, we observed a drop of 17 mmHg from baseline (60±6 mmHg) to 10 min post-induction (43±11 mmHg) in group P. In group S and group SP, no significant decrease in diastolic blood pressure was observed. When a comparison was made between group P versus group S, we observed a statistically significant difference at 1 min, at 3 min, 5 min, and 10 min. Between group P versus group SP, we observed a statistically significant difference at 1 min, 3 min, 5 min, and 10 min in group S and SP, we observed no significant drop in diastolic blood pressure (Figure 2).

Table 1: Demographic parameters of three groups

Parameter	Group P	Group S	Group SP	P value
n	50	50	50	
Age (months)	35±10.50	37±11	38±13	0.721
M/F	44/6	40/10	41/9	0.23
Weight (kg)	15.52±6.6	17.21±4.9	15.98±5.7	0.345
Duration of surgery (min)	30.12±10.2	32.56±12	35.60±7.8	0.95

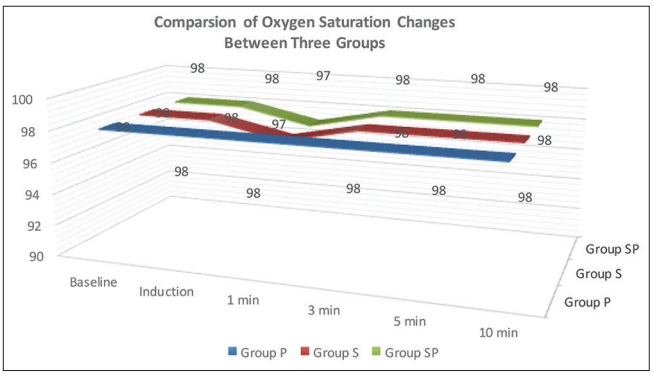

Figure 1: Comparison of oxygen saturation between the three groups

Adverse effects in three groups, hypotension was observed in group P which was statistically significant when compared with group S and group SP. None of the groups were found to be associated with any incidence of arrhythmia and bronchospasm (Figure 3).

DISCUSSION

Induction of anesthesia is a critical event and hemodynamic stability is an important factor during this period.

Table 2: Comparison of heart rate between three groups

Group P versus Group S					
Variable	**Group P**		**Group S**		**P-value**
HR (bpm)	**Mean (bpm)**	**Standard deviation**	**Mean (bpm)**	**Standard deviation**	
Baseline	99	4	100	9	0.777
Induction	99	4	99	9	0.531
1 min	95	7	92	8	0.036
3 min	91	12	90	12	0.045
5 min	86	17	82	14	0.026
10 min	84	19	72	17	0.045
Group P versus Group SP					
Variable	**Group P**		**Group SP**		**P-value**
HR (bpm)	**Mean (bpm)**	**Standard deviation**	**Mean (bpm)**	**Standard deviation**	
Baseline	99	4	97	5	0.017
Induction	99	4	97	6	0.033
1 min	95	7	97	7	0.293
3 min	91	12	97	9	0.007
5 min	86	17	97	11	0.001
10 min	84	19	97	11	0.001
Group S versus Group SP					
Variable	**Group S**		**Group SP**		**P-value**
HR (bpm)	**Mean (bpm)**	**Standard deviation**	**Mean (bpm)**	**Standard deviation**	
Baseline	100	9	97	5	0.068
Induction	99	9	97	6	0.093
1 min	92	8	97	7	0.021
3 min	90	12	97	9	0.032
5 min	82	14	97	11	0.001
10 min	72	17	97	11	0.041

Table 3: Comparison of systolic blood pressure between three groups

Group P versus Group S					
Variable	**Group P**		**Group S**		**P-value**
SBP (mmHg)	**Mean (mmHg)**	**Standard deviation**	**Mean (mmHg)**	**Standard deviation**	
Baseline	98	6	96	7	0.248
Induction	98	6	96	7	0.181
1 min	93	6	96	7	0.043
3 min	87	9	95	8	0.001
5 min	81	12	95	10	0.001
10 min	78	14	95	11	0.001
Group P versus Group SP					
Variable	**Group P**		**Group SP**		**P-value**
SBP (mmHg)	**Mean (mmHg)**	**Standard deviation**	**Mean (mmHg)**	**Standard deviation**	
Baseline	98	6	96	6	0.251
Induction	98	6	96	6	0.259
1 min	93	6	97	6	0.002
3 min	87	9	96	9	0.001
5 min	81	12	95	10	0.001
10 min	78	14	94	12	0.001
Group S versus Group SP					
Variable	**Group S**		**Group SP**		**P-value**
SBP (mmHg)	**Mean (mmHg)**	**Standard Deviation**	**Mean (mmHg)**	**Standard deviation**	
Baseline	96	7	96	6	0.869
Induction	96	7	96	6	0.717
1 min	96	7	97	6	0.419
3 min	95	8	96	9	0.665
5 min	95	10	95	10	0.872
10 min	95	11	94	12	0.652

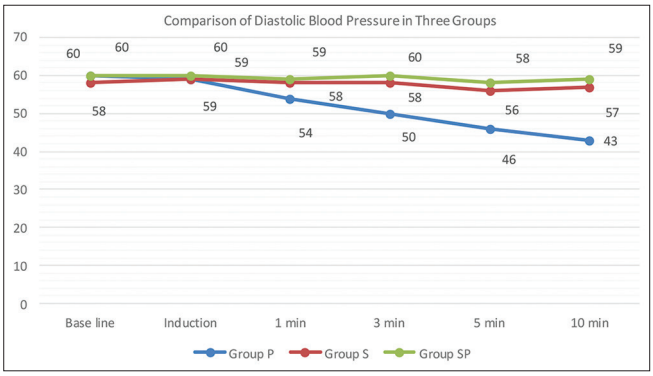

Figure 2: Comparison of diastolic blood pressure between three groups

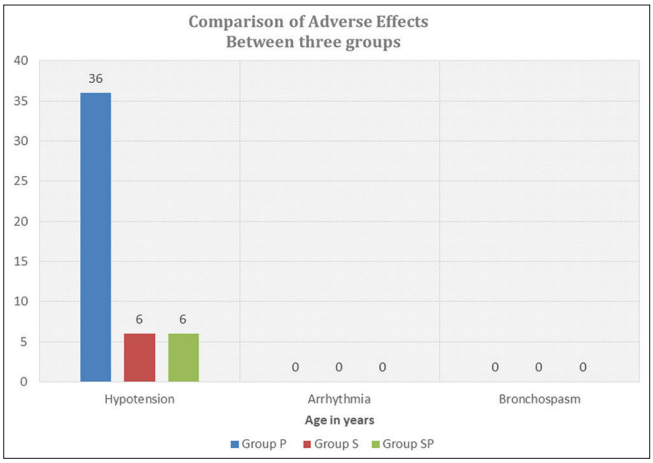

Figure 3: Comparison of complications between three groups

Induction can be achieved either by inhalational agents, intravenous agents, or co-induction using a combination of both. The present study showed that co-induction with propofol and sevoflurane was associated with a better hemodynamic profile than induction with these drugs as sole induction agents. While propofol induction decreased all hemodynamic parameters, sevoflurane induction primarily affected the heart rate. Co-induction provided balanced hemodynamics using a lesser dose and concentration of the agents.

The demographic variables in all three groups were statistically comparable. The observation of heart rate indicates that both group P and group S had a decrease in heart rate whereas in group SP no significant decrease in heart rate was observed. Similar to our study, Smith et al.,[15] observed a decrease in heart rate at 5 min and 10 min after induction in the sevoflurane group when compared with propofol. Sevoflurane mildly depresses myocardial contractility and systemic vascular resistance which leads to a decrease in heart rate. Mathew et al.[16] observed a decrease in heart rate in the propofol group at 1 min and 2 min post-induction in comparison with sevoflurane.

When we compared SpO_2 in three groups, no significant drop in saturation was observed. Similar to our study, Ravi et al.[3] observed no statistically significant difference in saturation when compared between propofol and sevoflurane. Balakrishnan[17] also observed no statistically significant change in saturation between propofol and sevoflurane.

The findings in systolic blood pressure indicate that group P observed a decrease in systolic blood pressure whereas in group S and group SP, no significant change in systolic blood pressure was observed. Similar to our study, Mathew et al.[16] observed a drop in systolic blood pressure in group P when compared to group S. Similarly, Vora et al.,[18] while comparing sevoflurane and propofol, observed a drop in systolic blood pressure in group P which was more at 2 min post-LMA insertion.

The findings indicate that group P observed a decrease in diastolic blood pressure whereas in group S and group SP, no significant change in diastolic blood pressure was observed. Similar to our study, Mathew et al.[16] observed a significant drop in diastolic blood pressure in the propofol group when compared with sevoflurane.

When we compared mean arterial blood pressure in three groups, we observed a drop of 18 mmHg from baseline (73±5 mmHg) to 10 min post-induction (55±11 mmHg) in group P. In group S and group SP, no significant change in mean arterial blood pressure was observed. When a comparison was made between group P versus group S, we observed a statistically significant difference at 1 min, 3 min, 5 min, and 10 min. Between group P versus group SP, we observed a statistically significant difference at 1 min, 3 min, 5 min, and 10 min. Between group S versus group SP, no statistically significant difference was observed. The findings indicate that group P observed a decrease in mean arterial pressure whereas in group S and group SP, no significant change in arterial blood pressure was observed. Similar to our study Bharti et al.,[19] observed a decrease in mean arterial pressure in the propofol group as compared to sevoflurane. Thwaites et al.[20] also observed a significant drop in mean arterial pressure with propofol at 2–5 min after induction as compared to 8% sevoflurane.

When we compared adverse effects in three groups, hypotension was observed in group P which was statistically significant when compared with group S and group SP. None of the groups were found to be associated with any incidence of arrhythmia and bronchospasm (Figure 3).

Limitations of the study

We could not perform single breath vital capacity induction which is considered superior to Tidal volume method, as

children less than 5 years of age may not cooperate for the same.

CONCLUSION

Co-induction with propofol and sevoflurane was associated with a better hemodynamic profile as compared to induction with these drugs as sole induction agents. While propofol induction decreased all hemodynamic parameters, sevoflurane induction primarily affected the heart rate.

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Author's Contributions:
AA- Definition of intellectual content, literature survey, prepared the first draft of the manuscript, implementation of study protocol, data collection, data analysis, manuscript preparation and submission of article; **SAM-** Concept, design, clinical protocol, manuscript preparation, editing, and manuscript revision; **KS-** Design of study, statistical analysis and interpretation, Review manuscript; **MJ-** Review manuscript; **ASM-** Literature survey and preparation of figures; **AHM-** Coordination and manuscript revision.

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