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Comparative Study of Inhalational vs. Intravenous Anesthesia in Pediatric Surgery: Safety and Recovery Profiles

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ABSTRACT

Background: Inhalational anesthesia uses a mask and breathing circuit to deliver anesthetic gases for induction and repair, which may delay recovery and cause additional side effects.

Methodology: Comparative observational research was carried out to compare inhalational and intravenous anesthesia in pediatric surgery. The study was conducted in Mohi-ud-Din Teaching Hospital, Mirpur AJK. Peds aged from 1 to 12 years old experiencing surgery were included in the study. Parental consent was obtained. The study excluded emergency surgery situations and those with major comorbidities like congenital heart diseases. The data was analyzed using IBM SPSS statistics 25. The duration of the study was from July 2023 to June 2024.

Results: Airway difficulties were more frequent in the inhalational group 20% compared to the intravenous group 4%. Hemodynamic instability affected 14% compared to 4% (p-value=0.02), and hypoxia happened in 10% compared to 2% with a p-value=0.015, indicating intravenous anesthesia was preferred. The inhalational group experienced a longer emergence time (15.0±3.0 compared to 8.2±2.3 minutes), higher postoperative pain levels (4.3±1.7 versus 2.7±1.2), and more nausea or vomiting (22% versus 6%) than the intravenous group. Satisfaction of parents was significantly higher in the intravenous group (96 percent) compared to inhalational (68 percent) with a p-value 0.004.

Conclusion: Intravenous anesthesia excels in inhalational anesthesia when it comes to safety, recovery time, and post-operative comfort. It was associated with fewer problems, shorter emergence times, and less post-operative pain and nausea. Parents preferred intravenous anesthesia because it provided higher satisfaction and improved recovery outcomes.

Keywords: Inhalation, Intravenous, Anesthesia, Pediatric Surgery

INTRODUCTION

Inhalation anesthetics such as the most used drugs in practice nowadays are nitrous oxide (NO), halogens, desflurane drug, isoflurane drug as well as sevoflurane are employed to persuade and maintain general anesthesia in the operation theater. Inhalation anesthetic drugs are medications that are commonly employed in operation theater to deliver general anesthesia (1). They can be used for preoperative anesthesia along with intravenous anesthetic drugs like midazolam drugs and propofol drugs during the surgery and in the context of intraoperation (2). Intravenous anesthesia can be used alone and in combination with inhalation and regional anesthesia. In pediatrics, intravenous anesthetics include the drug ketamine, propofol drug, thiopental drug, midazolam drug, NSAIDs, and opioids. General anesthesia using intravenous medications alone is gaining popularity for some reasons. (3). The only definite rationale for using a whole intravenous sedation/anesthesia approach in pediatrics is that there is a vulnerability to a cancer-causing condition called hyperthermia and there is a long family history of it in undiagnosed youngsters. (4).

A study conducted by Ortiz et al. found not enough proof to assess whether intravenously or inhalational anesthesia is protective and results in a quicker recovery in pediatric outpatient surgical techniques. (5). In pediatric surgery, intravenous anesthesia/sedation is linked to a decreased risk of postoperative nausea/vomiting with inhalational sedation/anesthesia. (6). In high-risk pediatric individuals, intravenous propofol drug induction is linked with a lower risk of perioperative inhalational adverse-events than inhalational sevoflurane drug. (7).

The protection and recovery patterns of inhalational anesthetic compared to intravenous anesthesia in pediatric surgery are not clear, with some indications involving additional pulmonary complications with inhalational induction of anesthesia (8). In pediatric outpatient care surgery, complete intravenous anesthesia/sedation with propofol lowered surgery discomfort and agitation when compared to sevoflurane drugs inhalation anesthesia. . (9) In pediatrics with congenital cardiac disease, inhalational sedation with sevoflurane creates higher surge suppression but better blood flow to the brain than intravenous anesthesia induction. (10)

This study compares the safety profiles of inhalational compared to intravenous anesthesia in pediatric surgical cases, with particular emphasis on recovery outcomes. It will compare important factors that affect emergence time and the number of postoperative complications. Furthermore, parental satisfaction and preferences for the selected anesthesia methods will be evaluated to gain a thorough comprehension of both clinical and patient-focused results.

METHODOLOGY

Comparative observational research was conducted to compare inhalational and intravenous anesthesia in pediatric surgery. The study was conducted in Mohi-ud-Din Teaching Hospital, Mirpur AJK. Data was collected after the approval of the institute review board committee. Children aged from 1 to 12 years were included in the study who were undergoing surgery. The duration of the study was from July 2023 to June 2024. Pediatrics scheduled for surgery were included in this research study. Parental consent was obtained. The study excluded emergency surgery situations and those with major comorbidities like congenital heart diseases were excluded from the study. The study collected information regarding demographics from participants like their age, weight, and gender. Two types of anesthesia were compared inhalation with the drug

sevoflurane and intravenous with the drug propofol. The frequency of complications such as airway problems and hemodynamic instability, was tracked to assess safety outcomes. Recovery outcomes included emergence time, post-operative pain levels, and the presence of nausea and vomiting, while parental satisfaction level was assessed using a standardized questionnaire. Descriptive statistics were applied to sum up demographics and baseline data. Categorical data like adverse events were analyzed by applying the chi-square statistical test while the variables that are continuous like emergence time were compared using an independent t-test. A p-value > 0.05 was statistically significant and data analyses were performed with IBM SPSS statistics 25. Before data collection, parents and guardians provided informed consent. The anonymity and security of patient information were preserved throughout the study duration.

RESULTS

100 cases were included in the study. The mean age of the inhalational group was 6.4 ± 2.0 years, while the intravenous group had a slightly higher mean age of 6.8 ± 2.2 years with a p-value of 0.65, which indicates there is no significant association. The gender distribution was comparable, with 27 males and 23 females involved in the inhalational group versus 25 males as well as 25 females in the intravenous group with a probability of 0.78. The mean weight was 18.0 ± 4.6 kilograms in the inhalational anesthesia group and 18.2 ± 4.2 kilograms in the intravenous group with a p-value of 0.71 indicating similar baseline characteristics among the two groups.

Table 1: Demographic Characteristics of Participants

Variable	Inhalational Group (Frequency=N=50)	Intravenous Group (Frequency=N=50)	P-value
Age (in years) (Mean $\pm$ SD)	6.4 ± 2.0	6.8 ± 2.2	0.65
Gender	Male: 27 (54%) Female: 23 (46%)	Male: 25 (50%) Female: 25 (50%)	0.78
Weight (kg) (Mean $\pm$ SD)	18.0 ± 4.6	18.2 ± 4.2	0.71

Table 2 compares the safety profiles of the two anesthetic procedures based on the incidence of adverse events or complications. Airway problems were substantially more common in the inhalational group, impacting 10 patients versus only two patients in the intravenous anesthesia group (probability of 0.008). Hemodynamic instability occurred in 7 patients in the inhalational anesthesia group versus 4% in the intravenous anesthesia group with a probability value of 0.02. Hypoxia was reported in 5 individuals in the inhalational group but an intravenous anesthesia group consisted of 1 pediatric patient (p-value of 0.015), illustrating a much-decreased incidence of adverse events or complications with intravenous anesthesia.

Table 2: Safety Profile – Incidence of Adverse Events

Adverse Event	Inhalational Group (n=50)	Intravenous Group (n=50)	p-value
Airway complications	10 (20%)	2 (4%)	0.008*
Hemodynamic instability	7 (14%)	2 (4%)	0.02*
Hypoxia	5 (10%)	1 (2%)	0.015*

Table 3 explains the recovery results, which include emergence time, postoperative discomforts, and nausea or vomiting. The inhalation group had a substantially longer mean emergence time (15.0 ± 3.0 min) than the intravenous group (8.2 ± 2.3 min) with a p-value of 0.05. The

inhalational group reported a greater post-operative pain score (VAS 0-10) with an average of 4.3 ± 1.7 , as compared to 2.7 ± 1.2 involved in the intravenous anesthesia group (p-value 0.01). Nausea/vomiting occurred more commonly in the inhalational group (22%) than in the intravenous anesthesia group (6%) (P-value 0.009), indicating intravenous anesthesia group had superior post-operative comfort.

Table 3: Recovery Outcomes

Outcome	Inhalational Group (n=50)	Intravenous Group (n=50)	p-value
Emergence Time (min) (Mean $\pm$ SD)	15.0 ± 3.0	8.2 ± 2.3	0.05*
Post-op Pain Score (VAS 0-10) (Mean $\pm$ SD)	4.3 ± 1.7	2.7 ± 1.2	0.01*
Nausea/Vomiting	11 (22%)	3 (6%)	0.09*

Table 4 represents parental satisfaction with the anesthesia technique employed. Overall satisfaction was much higher in the intravenous group, with 48 parents (96%) responding with satisfaction compared to 36 (72%) parents who reported the inhalational anesthesia group (p-value = 0.07). Similarly desire for future use of the same anesthesia modality was higher in the intravenous group with 47 parents expressing preference versus 34 parents included in the inhalational anesthesia group (p-value = 0.004). These results show that parents considered intravenous anesthesia as a superior alternative due to faster recovery and fewer side effects.

Table 4: Parental Satisfaction

Satisfaction Measure	Inhalational Group (n=50)	Intravenous Group (n=50)	p-value
Overall Satisfaction	36 (72%)	48 (96%)	0.007*
Preference for Future Use	34 (68%)	47 (94%)	0.004*

DISCUSSION

Today, there are a few choices for general anesthesia in children (1) inhalational and (2) intravenous anesthesia. Drugs such as sevoflurane, desflurane, isoflurane, and halothane as well as nitrous oxide (NO) are the inhalational anesthetics usually available for use in pediatrics. Intravenous anesthesia is becoming more common because of boosted drugs such as rapid-acting total intravenous anesthetic /sedative drugs, a good understanding of pharmacokinetic and pharmacodynamic combination methods for administration, non-polluted operation theatre area, and independence from airway equipment(11). Nevertheless, there are certain disadvantages like the requirement for knowledge of the procedure and the restricted presence of distillation pumps and intensive care instruments worldwide. (12).

Anesthesia type intravenous may be used alone and in conjunction with inhalation as well as regional anesthesia. In Pediatrics, intravenous anesthetics include drugs like ketamine, propofol drug, thiopental drug, midazolam drug, dexmedetomidine drugs, as well as opioids. The introduction of regular use of hypnotics and opioids has led to an increase in the adoption of general anesthetics using intravenous sedation mainly known as TIVA (13). In another study it was discovered that respiratory effects in pediatric anesthesia might be caused by preexisting diseases and the effect of anesthesia on respiratory functioning, resulting in hypoxemia. Knowing pediatric respiratory physiology allows anesthetists to anticipate and avoid failure of respiration. This review study looked at how anesthesia, posture, and techniques affect pediatric respiration. (14) Intravenous sedation has a lower incidence of respiratory and hemodynamic adverse impacts compared to inhalational anesthesia in pediatric patients. (8). According to our study outcomes,

airway problems were much more advanced in the inhalational anesthesia group compared to the intravenous group. Furthermore, hemodynamic instability and hypoxia were more common in the inhalational group. A strong association was seen which indicates that intravenous anesthesia can be associated with a lower risk of complications or adverse even making it a potentially safer choice. In another study, they discovered that intravenous anesthesia has a good safer profile with a lower frequency of airway problems, hemodynamic instability, and hypoxia in the inhalation anesthesia group. (15)

A study conducted by Amiri (16) found that in pediatric laparoscopic surgery, intravenous anesthesia is linked with a lowered risk of nausea/vomiting postoperatively than inhalational anesthesia. In another study, it was discovered that the drug propofol lowers postoperative vomiting/nausea as compared to isoflurane-nitrous oxide (NO) anesthesia though at a higher dose. (17). In our research study, we discovered that intravenous anesthesia resulted in rapid emergence, lower postoperative pain, and less nausea or vomiting than inhalational anesthesia. These data outcomes point to superior recovery and increased patient comfort with intravenous anesthesia.

According to Zielinska and the team. Included the advantages and disadvantages of intravenous versus inhalational induction of anesthesia in pediatrics but failed to specifically address parental satisfaction. (18) A high overall, parental satisfaction (96.7%) with anesthesia services with anesthesia and peri-anesthesia scoring 100 percent and 97.9 percent, respectively. Nevertheless, satisfaction ratings were significantly lower for the post-anesthesia care unit (96.7 percent) and data about patient care at home (91.3%). (19) Pediatric patient's parents preferred intravenous anesthesia over inhalational anesthesia, claiming improved recovery results and fewer adverse effects/adverse events (20) In our study we discovered that parents were much more satisfied with intravenous anesthesia (96%) than with inhalational anesthesia (72%), indicating an obvious preference for the former with a p-value of 0.007. Similarly, 94 percent of parents in the intravenous group preferred using the same sedation/anesthesia method again, versus 68% in the inhalational anesthesia group (p-value =0.004).

CONCLUSION

No significant differences in baseline demographic characteristics compared to the inhalation and intravenous anesthesia groups. Such as age, gender, and weight, indicating that the groups are comparable for future research studies. Intravenous anesthesia had a better safety profile than inhalational anesthesia with reduced rates of airway problems, hemodynamic instability as well as hypoxia, demonstrating its advantages in reducing adverse events, Intravenous anesthesia has more favorable recovery results than inhalational anesthesia. It is related to significantly shorter emergence times, lower postoperative pain levels, and a decreased incidence of vomiting/nausea suggesting higher postoperative comfort for pediatric patients. Parents choose intravenous anesthesia as compared to inhalational anesthesia because it has higher satisfaction ratings and stronger needs for future use, which is most likely owing to better recovery results and fewer adverse events.

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