E-ISSN 2250-0944
ISSN 2250-1150
Doi:10.48047/ijprt/16.01.246

Research Article

Effect of Sevoflurane versus Propofol-Based Anesthesia on the Hemodynamic Response and Recovery Characteristics in Patients Undergoing Congenital Diaphragmatic Hernia Repair

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Received: 21.12.25, Revised: 31.03.26, Accepted: 12.04.2026, Published: 30.04.26

ABSTRACT

Background: CDH is a severe congenital disorder that involves hernia of abdominal organs into the thoracic cavity, causing respiratory dysfunction and pulmonary hypoplasia. The ultimate treatment is surgical repair, but anesthetic management is important to provide hemodynamic stability and a safe postoperative course. Others The various methods of anesthesia can affect cardiovascular reactions during the operation and outcome post operative.

Objectives: The goal of this study was to compare how two anesthetics, sevoflurane- and propofol-based anesthetic drugs, influenced hemodynamics and recovery in patients having congenital diaphragmatic hernia repaired.

Methodology: A randomized comparative prospective study was carried out in 60 patients who were undergoing the repair of the CDH . Study was done From May 2025 to October 2025 at Department of Anesthesia, Khyber Teaching Hospital Peshawar. Patients were separated into two equal groups namely Group S which administered sevoflurane based anesthesia and Group P which administered propofol based anesthesia. Hemodynamic variables such as the heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure were measured at baseline and the various intraoperative phases. The recovery characteristics also included emergence time and the extubation time. The comparison of the results between the two groups was conducted through statistical analysis.

Results: The study findings revealed that patients in the sevoflurane group had relatively constant intraoperative hemodynamic parameters than patients under the propofol group. Intraoperative hypotension was more frequent in propofol. The two groups showed similar recovery features such as the emergence and extubation periods.

Conclusion: Anesthesia using sevoflurane offers a more favorable intraoperative hemodynamic stability but equal recovery outcomes when compared to anesthesia using propofol to patients undergoing congenital diaphragmatic hernia repair.

Keywords: Sevoflurane, Propofol, Congenital diaphragmatic hernia, Hemodynamic response, Anesthesia, Recovery characteristics.

INTRODUCTION

Congenital diaphragmatic hernia (CDH) is a critical, congenital defect in which the diaphragm is partially left undeveloped, leading to the herniation of abdominal organs into the thoracic cavity and interrupting with the regular development of the lungs. This dislocation of abdominal viscera causes pulmonary hypoplasia and permanent pulmonary hypertension, the main causes of morbidity and mortality of the neonates with this condition. The incidence of CDH is reported to be about 1 in 2, 500 live births and the condition is usually characterized by severe respiratory distress soon after birth as a result of impaired lung functioning as well as respiratory gas exchange [1,2]. The conventional form of management is the early stabilization and surgical repair, but perioperative care is also complicated due to the weak cardiopulmonary physiology that is linked with such a condition[3]. Pathophysiology of CDH plays a key role regarding the anesthetic control. The enhancement of lung volume and development of pulmonary vascular bed as a result of hernia of abdominal content into the thoracic cavity limit the growth of lung and limit development of lung compliance and pulmonary hypertension. These pathologic alterations will result in severe respiratory insufficiency and hemodynamic instability during anesthesia and surgery. This

means that patients with CDH who are going through surgery should be subjected to careful perioperative observation and a well-chosen anesthetic medication in order to prevent exacerbation of pulmonary hypertension or cardiovascular damage [4,5]. Proper oxygenation, prevention of barotrauma, and appropriate maintenance of hemodynamic parameters are key anesthetic concerns with this group of patients[6].

CDH is surgically corrected by maintaining and correcting bulging abdominal organs and repairing the diaphragmatic hiatus. Even though the procedure itself is a necessary condition, the period of anesthesia is quite problematic due to the fact that the cardiopulmonary reserve and functioning are frequently impaired in neonates with CDH, and their physiological background may be compromised as well. The anesthetic agents used in the operation should consequently offer sufficient anesthesia and analgesia without compromising the cardiovascular stability or avoiding respiratory depression [7,8]. Also, ventilation measures and fluid management need to be thoroughly controlled to prevent a quick change in the pulmonary artery pressure and systemic circulation.

During the CDH repair, general anesthesia is commonly used, there is a popular practice of inhalational and intravenous methods of anesthesia. Sevoflurane is the popular choice as an inhalational anesthetic in pediatric anesthesia as it has a quick-onset, low-blood-gas solubility, and low airway irritability. Sevoflurane is especially fit to use in neonates and infants during surgery since it is easy to induce and recycled with high speed with these properties [9,10]. Besides, sevoflurane maintains fairly constant hemodynamic parameters and also allows easy adjustments of anesthetic depth, which is valuable especially when dealing with patients in fragile cardiopulmonary condition.

Another widely used anesthetic drug is propofol which is particularly used to induce and maintain anesthesia intravenously. It is characterized by a quick action, other induction, and brief recovery. Propofol is also an antiemetic which has been shown to have a low post operative nausea and vomiting[9]. Propofol however can lead to dose-response hypotension as a result of systemic vasodilation and myocardial depression. This effect can cause unwanted hemodynamic unsteadiness during anesthesia in neonates and infants with impaired cardiovascular functioning due to reasons such as CDH and preterm birth [10].

Whether to use the inhalational anesthetic method or intravenous method of anesthesia is a subject of dynamic clinical research. Sevoflurane is an inhalational agent commonly used in the pediatric setting due to its allowance of titration and in other clinical conditions, because of its ability to induce spontaneous ventilation. On the other hand, the anesthesia of propofol is extensively administered, with easy predictability of its pharmacokinetics and optimal recovery. Even with these benefits, there is still an apprehension towards some cardiovascular depressive impact of propofol especially to patients with a low physiological reserve [11].

Maintaining hemodynamic stability of neonates undergoing CDH repair is of particular concern because of the potential of a rapid blood pressure, heart rate, or pulmonary vascular resistance fluctuation that can exacerbate and impair pulmonary hypertension and systemic perfusion. The intraoperative hypotension can impair organ perfusion, whereas too much sympathetic stimulation induced during intubation or surgery manipulation can induce pulmonary vasoconstriction. Thus, general anesthetics medications that involve stable hemodynamic effects without losing sufficient anesthetic effect are desirable in such operations [12].

Besides intraoperative stability, the nature of recovery is also a factor that should be put into consideration when choosing anesthetic agents. The early neurological and respiratory evaluation along with management of ventilatory in the postoperative period is facilitated by a rapid anesthetic recovery. Sevoflurane and propofol have a relatively fast recovery profile, although variations in emergence time, extubation time, and postoperative level of sedation can have an effect on clinical outcomes. The assessment of these parameters of recovery is thus crucial during the comparison of the methods of administration of anesthesia in pediatric surgery patients [13,14].

The best anesthetic method to use in repairing the CDH is still debatable, regardless of the improved steps and procedures in the neonatal unit as well as surgical processes. A number of studies have already been studied on the impacts of various anesthetic agents to cardiovascular stability and postoperative recovery but research results are scattered and more comparative research studies are warranted to develop evidence based recommendations. Knowledge of the hemodynamic implications and the recovery properties of the popular anesthetic drugs can assist the clinicians to choose the most suitable

anesthetic method in patients who need CDH repair done on them [15].

The current research will thus attempt to compare both sevoflurane and propofol-based anesthetic agents with regard to their impact on hemodynamic response and recovery properties in patients with congenital diaphragmatic hernia repair. This study aims to add value to the field of better anesthetic control in managing such a high-stress patient population in comparison with intraoperative cardiovascular stability and postoperative recovery, using the two anesthetic methods.

METHODOLOGY

Study Design

The aim of the study was to compare the effect of sevoflurane-based anesthesia versus propofol-based anesthesia on hemodynamic response and recovery factors in patients undergoing congenital diaphragmatic hernia repair. The study was developed as a prospective randomized comparative investigation. The study was done to compare the parameters of intraoperative cardiovascular stability and postoperative recovery in the two methods of anesthesia. Ethical consent was issued to the study by the institutional review board of the hospital that participated in the study and informed consent was given to each of the participants, i.e. parents or legal guardians, before they were enrolled into the study.

Study Setting and Population

The research was carried out at the Department of Anesthesiology in conjunction with the Department of Pediatric Surgery of a tertiary care hospital. The study population was made up of patients diagnosed with congenital diaphragmatic hernia who were planned to be provided with surgical repair under general anesthesia. Sixty patients were recruited and randomly divided into two homogenous groups. Group S and Group P were patients who were undergoing sevoflurane and propofol anesthesia respectively. The randomization procedure was conducted through randomization by computer as a randomization method to reduce the occurrence of selection bias and equalise the distribution of the study in the groups.

Inclusion and Exclusion Criteria

The inclusion criteria to be used in the study were patients diagnosed with congenital diaphragmatic hernia and who will undergo elective surgical repair. The study was restricted to exclude patients whose physical status classification under American Society of Anesthesiologists was less than II or III. The study did not allow the inclusion of patients suffering from severe chronic congenital heart disease, hypersensitivity to anesthetic drugs, and malignant hepatic or renal damage, in addition to emergency surgical patients. The criteria were used to provide a level of uniformity in the study population with the intention of eliminating the possibility of confounding factors that may affect hemodynamic events.

Anesthetic Procedure and Monitoring

All patients received standard preoperative evaluation and were observed by standard anesthetic monitoring approaches. They were electrocardiography, noninvasive blood pressure, pulse oximetry and capnography. Group S In Group S, sevoflurane was administered in an oxygen-air mixture in order to induce and maintain anesthesia. In Group P, the induction of anesthesia was done with intravenous injections of propofol, and further traveled with continuous propofol infusion. Other drugs including the muscle relaxants and painkillers were also given following the rules and regulations of the institution. The data concerning the heart rate, systolic blood pressure, diastolic blood pressure, and mean arterial pressure were monitored at baseline, post-induction, post-intubation, periodically during the course of surgery and at a specific period following extubation.

Data Collection and Statistical Analysis

The data recorded in the course of the study consisted of demographic considerations as well as intraoperative hemodynamic considerations and recovery considerations like the emergence time and extubation time. All the gathered information was put into statistical software to be analyzed. The variables were used as continued where mean and standard deviation were used to express continuous variables and frequency and percentage used to express categorical variables. The independent sample T-test of continuous variables was used to analyze difference between the two groups and chi-square test was used to analyze difference of categorical variables. A p-value of below 0.05 was taken to be significant.

RESULTS

Demographic and Baseline Characteristics

The current study involved a total of sixty patients with a congenital diaphragmatic hernia, which was randomly assigned to two equal groups. The patients at Group S were treated using sevoflurane-based anesthesia but propofil-based anesthesia was used in Group P. The

demographic characteristics of the study population at the baseline are summarized in Table 1. The average patient age was 8.6±3.2 days versus 8.9 + 3.5 days in the sevoflurane and propofol groups respectively. On the same note, Group S had a mean body weight of 3.12 + 0.41 kg and Group P had a mean body weight of 3.08 + 0.39 kg. The physical stature of ASA and gender between the two groups were also similar. Statistical analysis showed that there were no significant differences between the groups in these baseline variables ($p > 0.05$), showing that the two groups were well matched before anesthesia was given. These results affirm the fact that the latter variation in development of hemodynamic parameters and recovery was probably associated with the employed anesthetic methods instead of demographics.

Table 1: Demographic and Baseline Characteristics of Patients

Variable	Group S (Sevoflurane) n=30	Group P (Propofol) n=30	p-value
Age (days)	8.6 ± 3.2	8.9 ± 3.5	0.74
Weight (kg)	3.12 ± 0.41	3.08 ± 0.39	0.68
Gender (Male)	17 (56.7%)	16 (53.3%)	0.79
Gender (Female)	13 (43.3%)	14 (46.7%)	
ASA II	18 (60%)	17 (56.7%)	0.79
ASA III	12 (40%)	13 (43.3%)	
Duration of Surgery (minutes)	92.4 ± 11.6	94.1 ± 12.2	0.56

Baseline Hemodynamic Parameters

Table 2 shows the baseline cardiovascular parameters recorded prior to the induction of anesthesia. Group S had a mean of 142.5 averages with a standard deviation of 11.3 beats per minute and Group P had 141.8 averages with a standard deviation of 10.9 beats per minute. The mean, baseline systolic, and diastolic pressures were also similar across the groups with there being no statistically significant difference in the pressures. These results meant that the cardiovascular conditions of the two groups were similar prior to the start of anesthesia thus making intraoperative comparisons of sevoflurane and propofol possible.

Table 2: Baseline Hemodynamic Parameters before Induction

Parameter	Group S (Sevoflurane)	Group P (Propofol)	p-value
Heart Rate (beats/min)	142.5 ± 11.3	141.8 ± 10.9	0.81
Systolic BP (mmHg)	72.4 ± 6.8	73.1 ± 7.2	0.69
Diastolic BP (mmHg)	41.6 ± 4.9	42.2 ± 5.1	0.63
Mean Arterial Pressure (mmHg)	51.9 ± 5.7	52.5 ± 5.4	0.67
SpO_2 (%)	95.6 ± 2.1	95.1 ± 2.4	0.42

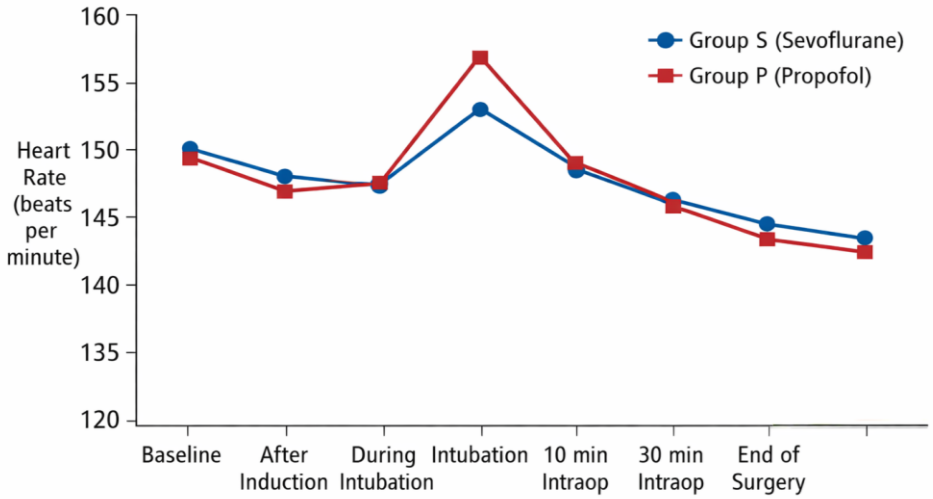
Intraoperative Heart Rate Changes

The trends of changes in the intraoperative heart rate at various steps of the surgery are presented in Table 3, whereas the general pattern of the changes is seen in Figure 1. Heart rate slowed slightly after the induction of anesthesia in both groups but again, there was greater slowing of the heart rate by propofol group. In the intubation, the two groups exhibited an increase in the heart rate, which was indicative of sympathetic stimulation, but the propofol group had a small increase. Heart rate slowly decreased to the baseline in the two groups as the surgical procedure continued. As it was shown in Figure 1, patients who were treated with sevoflurane had rather equal values of heart rate during the intraoperative time as compared with patients fed with propofol. This implies that sevoflurane can be used in surgical practice to achieve cardiovascular stability.

Table 3: Comparison of Heart Rate at Different Time Intervals

Time Interval	Group S (Sevoflurane)	Group P (Propofol)	p-value
Baseline	142.5 ± 11.3	141.8 ± 10.9	0.81
After Induction	139.7 ± 10.6	132.4 ± 11.1	0.02
During Intubation	146.3 ± 12.1	150.7 ± 13.5	0.18
10 min Intraoperative	138.6 ± 9.7	134.5 ± 10.2	0.11
30 min Intraoperative	136.2 ± 8.9	131.7 ± 9.6	0.06
End of Surgery	134.4 ± 9.1	130.9 ± 9.8	0.14

Figure 1: Heart Rate Trends During the Intraoperative Period



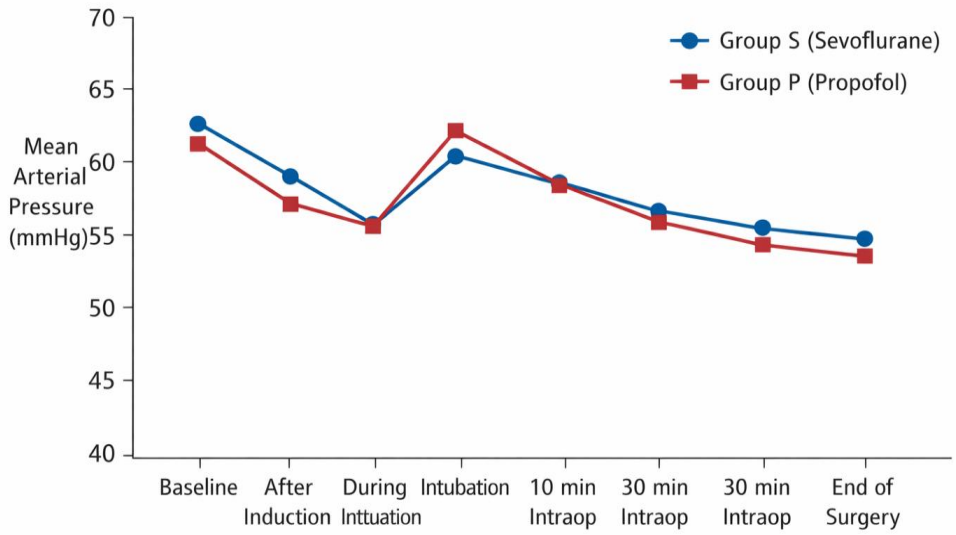
Intraoperative Blood Pressure and Mean Arterial Pressure

The results on the comparison of systolic, diastolic blood pressure rates, and the mean arterial blood pressure rates among two groups under varying periods of the surgical procedure are summarized in Table 4, and the tendency of mean arterial pressure alterations is demonstrated in Figure 2. Patients under the propofol group reported a significant magnitude drop in blood pressure post induction in comparison with those in the sevoflurane group. The stable value of the mean arterial pressure in Group S during the procedure was comparatively relatively stable and appeared more clearly in Group P. According to but Figure 2, it is apparent that sevoflurane had more stable hemodynamic value during the surgery whereas propofol had more fluctuations, especially during the induction stage. The above findings have indicated that the use of sevoflurane inhalation anesthesia can provide a better control of hemodynamic parameters during the intraoperative period.

Table 4: Comparison of Blood Pressure during Surgery

Parameter	Group S (Sevoflurane)	Group P (Propofol)	p-value
SBP After Induction	70.8 ± 6.1	64.2 ± 7.3	0.001
SBP During Intubation	76.5 ± 7.2	78.9 ± 8.4	0.23
SBP 30 min Intraoperative	71.4 ± 6.4	66.7 ± 7.1	0.01
DBP During Surgery	39.8 ± 4.5	36.6 ± 4.8	0.02
MAP During Surgery	50.3 ± 5.1	46.8 ± 5.7	0.01

Figure 2: Mean Arterial Pressure Changes During Different Stages of Surgery



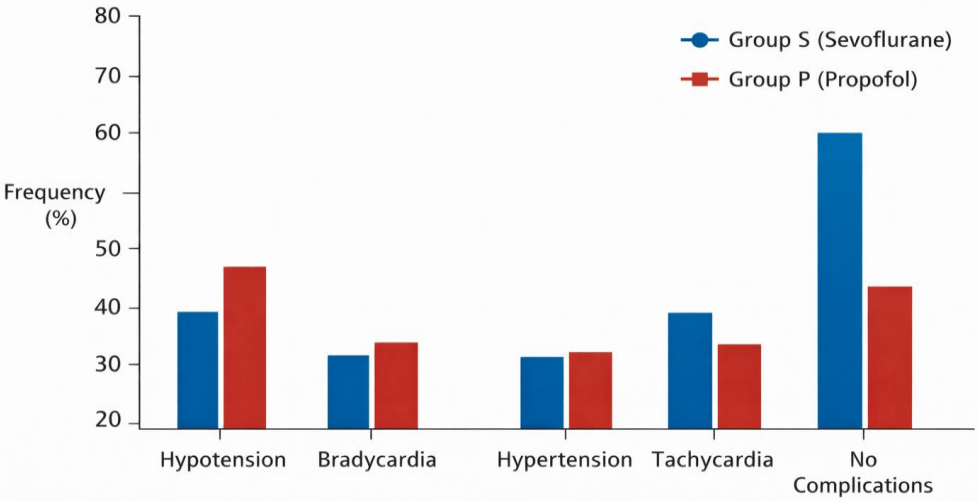
Intraoperative Complications

Frequency of intraoperative complications noted in the two groups are shown in Table 5, and distribution of the complications in Figure 3. The rate of hypotension was higher in the propofol group than in the sevoflurane group. Likewise, incidence of both bradycardia and tachycardia were a bit higher in the propofol group, but this was not significant in all. Higher percentage of patients in sevoflurane group did not occur with any intraoperative complications as opposed to propofol group. The figurative comparison in Figure 3 shows clearly that the frequency of hemodynamic disturbances in patients under sevoflurane anesthesia was reduced, which implies the intraoperative stability.

Table 5: Incidence of Intraoperative Hemodynamic Complications

Complication	Group S (Sevoflurane) n (%)	Group P (Propofol) n (%)	p-value
Hypotension	3 (10%)	9 (30%)	0.04
Bradycardia	2 (6.7%)	4 (13.3%)	0.39
Hypertension	1 (3.3%)	2 (6.7%)	0.55
Tachycardia	3 (10%)	5 (16.7%)	0.45
No Complications	21 (70%)	10 (33.3%)	0.003

Figure 3: Intraoperative Complications in Sevoflurane and Propofol Groups



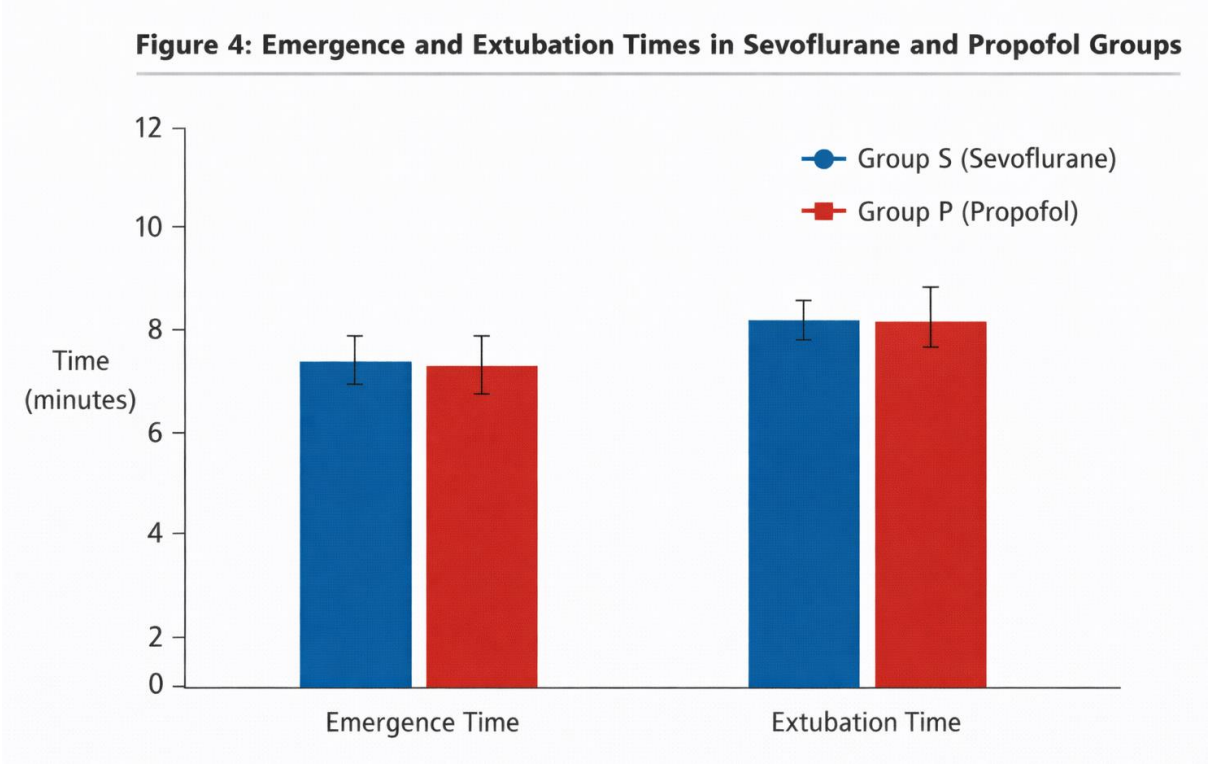
Recovery Characteristics

There were differences in recovery characteristics between the two groups in terms of emergence time and extubation time which are the values of Table 6 and presented graphically in Figure 4. The emergence time of sevoflurane was 8.4 2.3 minutes as opposed to 7.9 2.1 minutes of propofol. Equally, the extubation time took a little more time in Group S compared to Group P. Although there were these few differences, statistical analysis indicated that there was no significant difference between the recovery times in the two anesthetic methods. As shown in Figure 4, the figure of the graphical comparison indicates that both groups had equal recovery profiles which indicated that the use of sevoflurane did not produce any significant delay in postoperative recovery.

Table 6: Comparison of Recovery Characteristics

Parameter	Group S (Sevoflurane)	Group P (Propofol)	p-value
Emergence Time (minutes)	8.4 ± 2.3	7.9 ± 2.1	0.37
Extubation Time (minutes)	10.6 ± 2.8	9.8 ± 2.5	0.24
Time to Recovery of Consciousness (minutes)	12.3 ± 3.1	11.7 ± 2.9	0.43
Time to Stable Spontaneous Breathing (minutes)	13.7 ± 3.5	12.8 ± 3.2	0.31

Figure 4: Emergence and Extubation Times in Sevoflurane and Propofol Groups



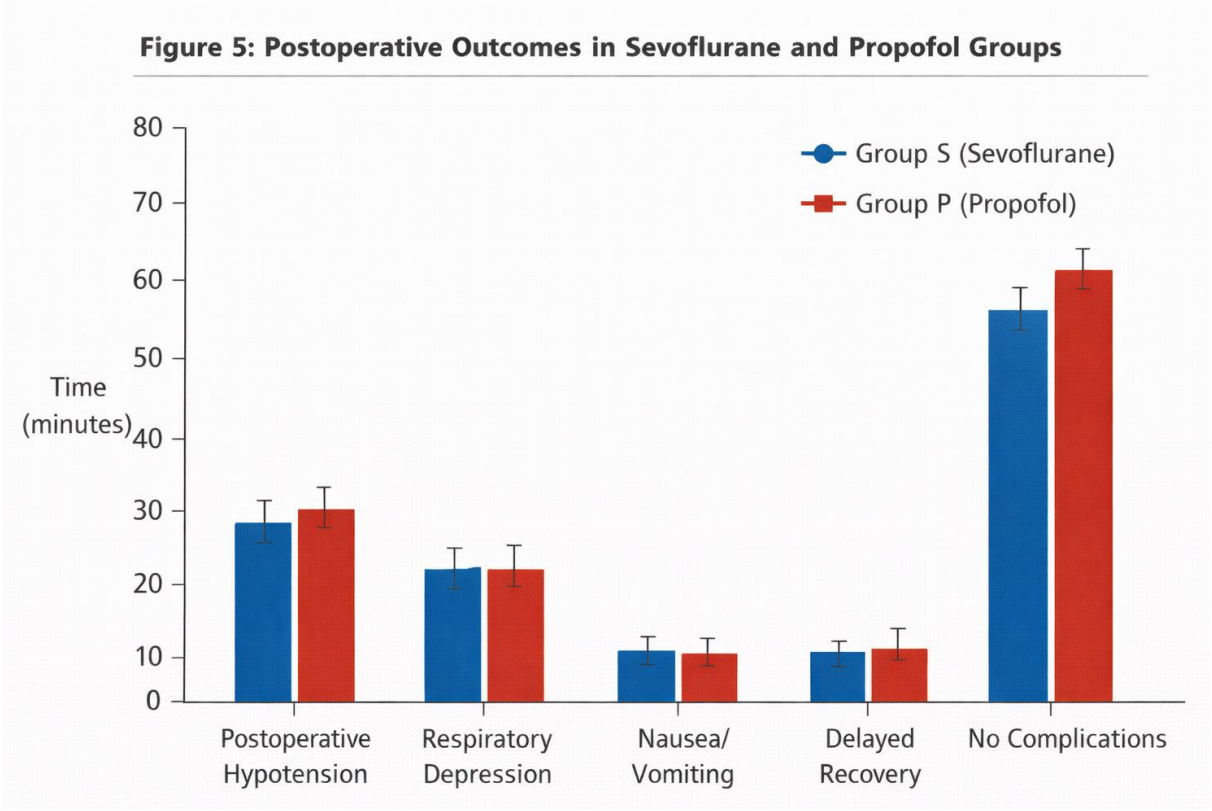
Postoperative Outcomes

The results of the study population in the terms of the postoperative results are summarized in Table 7 and their distribution is shown in Figure 5. Hypotension post operation, respiratory depression, nausea or vomiting as well as delayed recovery were noted both in the groups though with a little higher overall occurrence in the propofol group. A higher frequency of patients of the sevoflurane group did not develop any postoperative complications as opposed to the propofol group. Figure 5 shows a graphical representation of the fact that sevoflurane anesthesia was also related to a positive profile of postoperative outcome. Based on these observations, it could be concluded that sevoflurane can offer not only superior operative stability but also a little bit superior outcomes of postoperative recovery among the patients with congenital diaphragmic hernia repair.

Table 7: Postoperative Complications

Complication	Group S (Sevoflurane) n (%)	Group P (Propofol) n (%)	p-value
Postoperative Hypotension	2 (6.7%)	5 (16.7%)	0.23
Respiratory Depression	3 (10%)	4 (13.3%)	0.69
Nausea/Vomiting	1 (3.3%)	3 (10%)	0.30
Delayed Recovery	1 (3.3%)	2 (6.7%)	0.55
No Complications	23 (76.7%)	16 (53.3%)	0.04

Figure 5: Postoperative Outcomes in Sevoflurane and Propofol Groups



DISCUSSION

The current research compared the impact of sevoflurane based anesthesia and propofol based anesthesia on the intraoperative hemodynamic response and post operative recovery features in patients with a congenital diaphragmatic hernia repair. The results showed that patients who were put under sevoflurane had more positive cardiovascular parameters when undergoing surgery than those who were under propofol. Despite the fact that both forms of anesthetic in use gave comparable amounts of recovery, the sevoflurane-based group had less instances of intraoperative hypotension and slightly less frequency of postoperative problems. These results justify the use of an anesthetic agent that maintains cardiovascular stability in those neonates whose cardiopulmonary physiology is compromised.

Congenital diaphragmatic hernia is one disease where hemodynamic stability is critically important since such patients are often characterized by pulmonary hypoplasia and pulmonary hypertension persisting. Pulmonary hypertension and impaired organ perfusion can be exacerbated by sudden reductions in blood pressure or systemic vascular resistance. In the present research, the mean arterial pressure reduced even greater between the propofol group following induction of anesthesia. This fact is in tandem with the pharmacology of propofol that causes a systemic vasodilation and negative inotropic effect which leads to inotropism. Morton et al. also reported similar findings by establishing that the method of propofol anesthesia among children has a positive correlation with larger blood pressure changes during the induction period than inhalational anesthesia [16]. These results indicate the observation that the intravenous anesthetic agents can induce a worse cardiovascular depression in the neonatal populations at risk.

The current research also indicated that the variances of the heart rate were more pronounced in the propofol group especially at the time of induction and intubation. Sevoflurane on the contrary showed comparatively constant values of heart rates, during the intraoperative period. This was also observed when Elshalakany et al., established

that sevoflurane was better than other sedative anesthetics due to its quick titratability and minimal myocardial depressive impact on hemodynamic stability on children anesthetized [17]. This effect of sevoflurane on enabling the fine regulation of the anesthetic depth could help reduce sympathetic excitation when surgical manipulation occurs.

The difference between the two anesthetic methods can also be indicated by intraoperative complications that were witnessed in the current research paper. The propofol group had more hypotension than the sevoflurane group. Chidambaran et al., also described the similar results and stated that the use of propofol-based anesthesia in children was also linked to the higher rate of hypotension when compared to the inhalational anesthetics [18]. Such results affirm the need to consider anesthetic agents with minimal cardiovascular disturbances especially in patients with weakened cardiopulmonary malfunctions.

Recovery characteristics were as well analyzed to check on whether postoperative outcomes were influenced with the help of anesthetic technique. The finding indicated that there were no differences in the emergence and extubation time between the sevoflurane and propofol groups. This result is supported by a number of studies which carried out that sevoflurane and propofol are both suitable in providing a rapid recovery because of their desirable pharmacokinetic attributes. Brioni et al., reported the inhalational anesthetics like sevoflurane are very quickly removed by the respiratory system and consciousness returns sooner after the surgery [19]. On the same note, the short half-life of propofol has been identified to be redistributed quickly which leads to quickness out of anesthesia.

The postoperative outcomes proposed by the current study indicated that there was a slight reduction in the number of complications in the sevoflurane group, as compared to propofol group. Even though both groups experienced respiratory depression and delayed recovery, the number of patients who did not have postoperative complications was more significant in the group of sevoflurane delivered anesthesia. This conclusion can be explained by the studies of Wu et al., who concluded that the sevoflurane anesthesia was considered to be connected with the maintenance of stable respiratory performance and positive postsurgical outcomes in pediatric surgery patients [20].

Implications of the Study

The clinical implication of the findings of this study in the context of anesthetic care of neonates in case of congenital diaphragmatic hernia repair is essential. The findings indicate that sevoflurane can be used to offer better intraoperative hemodynamic stability without having significant differences in their recovery properties compared to the use of propofol. This can be helpful to the anesthesiologists in terms of the choice of anesthetics that minimize any perioperative cardiovascular disturbances and enhance safety in high-risk neonatal surgical operations.

Limitations

Regardless of the useful information presented using this study, a number of limitations are to be realized. The sample size used in the study was relatively small, and this could be a limitation to the generalization of the results. Moreover, the research was carried out in one medical facility, and the results can be different in other healthcare organizations due to different anesthetic guidelines. This study did not involve any long-term postoperative outcomes and neurodevelopmental consequences of anesthetic exposure.

CONCLUSION

To sum up, patients with congenital diaphragmatic hernia repair can receive sevoflurane-based anesthesia as well as propofol-based anesthesia. Nevertheless, sevoflurane was shown to have superior intraoperative hemodynamic capacity and fewer cases of complication than propofol. There were similar recovery features in the two methods of anesthetics. These results indicate that the sevoflurane might be a better choice of anesthetic drugs in the maintenance of cardiovascular stability in neurosurgical operations on the neonate.

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