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**RESEARCH ARTICLE**

# Recovery from Sevoflurane Anesthesia: A Comparism with Isoflurane Anesthesia in pediatric undergo tonsillectomy with or without adenoidectomy under general anesthesia

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**ABSTRACT**

Isoflurane and sevoflurane are widely used anesthetics in pediatric anesthesia. Adverse effect including postoperative nausea and vomiting are common. Prolonged recovery time and emergency time are also troubling anesthesiologists, so in this study, we aimed at performing a comprehensive-study concerning the emergence and recovery characteristics of these inhaled anesthetic in tonsillectomy and adenoidectomy pediatric patients.This study is designed to compare recovery in patients receiving sevoflurane or isoflurane for maintenance in pediatric patients undergo tonsillectomy with or without adenoidectomy under general anesthesia. A randomized, blind clinical trial 60 patients, 30 patients in sevoflurane group and 30 patients in isoflurane group , comparing recovery in pediatric patients with American Society Anaesthiologist I-II between (5-15years), were planned to undergo tonsillectomy with or without adenoidectomy duration 45 minute to 1 hour, under general anesthesia, Induction with propofol and rocuronium with sevoflurane and isoflurane for maintenance, assessment and monitoring by steward score Among the studied groups revealed a significant more frequent laryngospasm in Sevoflurane group, compared to the Isoflurane group, and significantly longer mean time from switching off inhalational agent to reversal agent in Sevoflurane than Isoflurane group conversely, the differences in the times at the subsequent three check points) were statistically insignificant. The scores statistically in significant at the subsequent check points, No significant variation in the incidence of nausea and vomiting, the pulse rate, respiratory rate, or oxygen saturation rate between both groups at different time of assessment, in all comparisons, We concluded that Isoflurane is a safe alternative to sevoflurane for pediatric surgery, less complication, smoother recovery Sevoflurane group had more side effects (agitation, Laryngeal spasm, faster requirement for analgesia, prolong recovery. Awakening time was surprisingly slower with sevoflurane

## INTRODUCTION

Inhalation anesthetics are the most common drugs used for the provision of general anesthesia. Adding only a fraction of a volatile anesthetic to the inspired oxygen results in a state of unconsciousness and amnesia. When combined with intravenous adjuvants, such as opioids and

benzodiazepines, a balanced technique is achieved those results in analgesia, further sedation/hypnosis, and amnesia. Inhaled anesthetics for surgical procedures are popular because of their ease of administration and the clinician's ability to reliably monitor their effects with both clinical signs and end-tidal concentrations. In addition, the volatile anesthetic gases are relatively inexpensive in terms of overall cost. Sevoflurane and isoflurane are the most popular potent inhaled anesthetics used in adult surgical procedures Some unique differences might influence the clinician's selection process depending on the patient's age, health, and the surgical procedure [1]

Isoflurane Is a halogenated methyl ethyl ether that is a clear, nonflammable liquid at room temperature and has a high degree of pungency. It is the most potent of the volatile anesthetics in clinical use, has great physical stability, and undergoes essentially no deterioration during storage for up to 5 years or on exposure to sunlight. It has become the "gold standard" anesthetic since its introduction in the 1970s. There was a brief period of controversy concerning the use of isoflurane in patients with coronary disease because of the possibility for coronary "steal" arising from the potent effects of isoflurane on coronary vasodilation. In clinical use, however, this has been, at most, a rare occurrence[2]

Sevoflurane Is a sweet smelling, completely fluorinated methyl isopropyl ether The blood: gas solubility of sevoflurane is second only to desflurane in terms of potent volatile anesthetics [3], The blood-gas partition coefficient of sevoflurane is one-half to one-third that of isoflurane (0.69 vs. 1.38)[4], Sevoflurane is approximately half as potent as isoflurane, and some of the preservation of potency, despite fluorination, is because of the bulky propyl side chain on the ether molecule. Its pleasant odor, lack of pungency nonirritating to the airway, and potent Broncho dilating characteristics make sevoflurane administration via the facemask for induction of anesthesia in both children and adults a reasonable alternative to IV anesthetics. Sevoflurane is half as potent a coronary vasodilator as isoflurane, but is 10 to 20 times more vulnerable to metabolism than isoflurane[5].

**For Maintenance of Anesthesia**

The volatile anesthetics are clearly the most popular drug used to maintain anesthesia. They are easily administered via inhalation, they are readily titrated, they have a high safety ratio in terms of preventing recall, and the depth of anesthesia can be quickly adjusted in a predictable way while monitoring tissue levels via end-tidal concentrations. They are effective regardless of age or body habitus. They have some properties that prove beneficial in the operating room, including relaxation of skeletal muscle, preservation of cardiac output and CBF, relatively predictable recovery profiles, and organ protection from ischemic injury. Some of the drawbacks to the use of the current volatile anesthetics are the absence of analgesic effects, their association with postoperative nausea and vomiting[6, 7]

**Minimum Alveolar Concentration**

Pharmacodynamics effects of anesthetics are based on their dosing. In the case of inhaled agents, we describe dose as the minimum alveolar concentration or MAC. MAC is the alveolar concentration of an anesthetic at one atmosphere (in volume %) that prevents movement in response to a surgical stimulus in 50% of patients. It is analogous to the ED50 expressed for intravenous drugs and can be used to compare anesthetic potency, that is, the lower the MAC the more potent the agent. Movement to a surgical stimulus, commonly abdominal incision, has been used to establish the MAC for each inhaled anesthetic. Manufacturer's recommendations and clinical experience establish 1.2 to 1.3 times MAC as a dose that will often prevent patient movement during a surgical stimulus. For example, an alveolar concentration of 1.2–1.3 MAC required to consistently prevent patient movement during surgical stimuli (e.g., incision) in about 95% of patients (an approximation of the ED95)8. The MAC values for sevoflurane and isoflurane are 2.05%, and 1.15%, respectively[9]

**Hemodynamics**

The cardiac, vascular, and autonomic effects of the volatile anesthetics have been defined through a number of studies carried out in human volunteers not undergoing surgery.9–13 In general, the information from these volunteer studies has translated well to the patient population commonly exposed to these anesthetics during elective and emergent surgeries. A common effect of the potent volatile anesthetics has been to decrease BP in a dose-related fashion with essentially no differences noted between the volatile anesthetics at equianesthetic concentrations[10]

Their primary mechanism to decrease BP is via a potent effect to relax vascular smooth muscle leading to decreases in regional and systemic vascular resistance, they have only minimal effects on cardiac output. In volunteers, sevoflurane up to about 1 MAC does not change HR while isoflurane result in 5% to 10% increases in HR from baseline[11,12,13]. Both desflurane and, to a lesser extent, isoflurane has been associated isoflurane has been associated with transient and significant increases in HR during rapid increases in the inspired concentration of this anesthetic.[13,14, 15], the mechanism(s) underlying these transient HR surges is likely due to the relative pungency of this anesthetic, which stimulates airway receptors to elicit a reflex tachycardia16, the tachycardia can be lessened with opioid or α2-agonist pretreatment .[16]

**Rocuronium**

Is structurally similar to pancuronium and vecuronium. Because of its low potency, the high plasma concentration achieved after bolus administration decreases rapidly, such that its duration of action in patients with normal renal and hepatic function is determined mostly by its redistribution, and not its elimination. Unlike vecuronium, rocuronium metabolites are minimal, with very low neuromuscular blocking activity (17-OH rocuronium), so the risk of accumulation is minimal. In many cases, rocuronium has replaced the use of SCh in the RSII sequence. At doses of 3.5 to 4 × ED95 (1.0 to 1.2 mg/kg), the onset rivals that of SCh, with similar intubating conditions.[17]

Similar to vecuronium, rocuronium does not cause significant hemodynamic perturbations and releases no histamine. Allergic reactions have been documented, and the rates of anaphylaxis (in Australia and New Zealand) are higher with rocuronium and SCh than any other NMBAs.[18-19]

Is an intermediate-duration. Because of its low potency, the high plasma concentration achieved after bolus administration decreases rapidly, such that its duration of action in patients with normal renal and hepatic function is determined mostly by its redistribution, and not its elimination, rocuronium metabolites are minimal, with very low neuromuscular blocking activity (17-OH rocuronium), so the risk of accumulation is minimal[20].

Inhalational anesthetic agents potentiate neuromuscular block (desflurane > sevoflurane > isoflurane > halothane > nitrous oxide), likely by direct effects at the post junctional receptors. Higher concentration (minimum alveolar concentration [MAC]) and longer agent exposure will potentiate the neuromuscular block to a greater extent[21].

**Tonsillectomy and Adenoidectomy**

As important parts of the inner ring of the pharyngeal lymphatic ring, the tonsil and the adenoid are the first immune line of defense for the upper respiratory tract of the human body. When children's immune function is low, tonsil and adenoid tissues cause hypertrophy and chronic inflammation once stimulated by external pathogens[22].In recent years, children with tonsil and adenoid hypertrophy are very common , Tonsil hypertrophy leads to upper respiratory tract infection in children, and local inflammation, thereby resulting in systemic diseases .[23]

. Untreated adenoidal hyperplasia may lead to nasopharyngeal obstruction, causing failure to thrive, speech disorders, obligate mouth breathing, and sleep disturbances, orofacial abnormalities with a narrowing of the upper airway, and dental abnormalities. Surgical removal of the adenoids is usually accompanied by tonsillectomy; however, purulent adenoiditis, despite adequate medical therapy, and recurrent otitis media with effusion secondary to adenoidal hyperplasia are improved with

adenoidectomy alone. Tonsillectomy is one of the more commonly performed pediatric surgical procedures.[24].

Chronic or recurrent acute tonsillitis, peritonsillar abscess, tonsillar hyperplasia, and obstructive sleep apnea syndrome (OSAS) are the major indications for surgery. Tonsillar hyperplasia may lead to chronic airway obstruction resulting in sleep apnea, carbon dioxide (CO2) retention, cor pulmonale, failure to thrive, swallowing disorders, and speech abnormalities. These risks are eliminated with removal of the tonsils. Obstruction of the oropharyngeal airway by hypertrophied tonsils leading to apnea during sleep is an important clinical entity referred to as obstructive sleep apnea syndrome Most children have tremendous improvement in their symptoms after tonsillectomy[25]

The safe management of the pediatric patient undergoing surgery of the nose, and throat is particularly challenging to the anesthesiologist. The restricted spaces in the airway of the child require an understanding and cooperative relationship between surgeon and anesthesiologist, and the use of specially adapted equipment suitable to these cramped areas,The goals of the anesthetic management for tonsillectomy and adenoidectomy are to render the child unconscious, to provide the surgeon with optimal operating conditions, to establish intravenous access to provide a route for volume expansion and medications when necessary, and to provide rapid emergence so that the patient is awake and able to protect the recently instrumented airway[26] .

Anesthesia is commonly induced with a volatile anesthetic agent, oxygen mask. Parental presence in the operating room (OR) during mask induction may be helpful in the anxious unpremeditated child. Tracheal intubation is best accomplished under deep inhalation anesthesia or aided by a short-acting nondepolarizing muscle relaxant. Many clinicians may choose to eliminate the neuromuscular blocking agent in favor of enhancing the depth of anesthesia with the use of propofol. Acetaminophen can be used as part of a multimodal pain regimen to reduce opioid consumption, particularly for patients having surgery for treatment of OSA[27].

Emergence from anesthesia should be rapid, and the child should be alert before transfer to the recovery area. The child should be awake and able to clear blood or secretions from the oropharynx as efficiently as possible before removal of the endotracheal tube. Maintenance of airway and pharyngeal reflexes is essential in the prevention of aspiration, laryngospasm, and airway obstruction. There is no difference in the incidence of airway complications on emergence between patients who are extubated awake and those who are deeply anesthetized.[28]

The Steward Recovery30Score had been used for assessment recovery, permits a simple record of important stages of recovery from general anesthesia.

The Simplified Post-Anesthetic Recovery Score-

**Consciousness**-

Awake 2

Responding to stimuli 1

Not responding 0

**Respiration**-

Airway Coughing on command or crying 2

Maintaining good airway 1

Airway requires maintenance 0

**Movement** -

Moving limbs purposefully 2

Non-purposeful movements 1

Not moving 0[29]

**Aim of study**

This study is designed to compare recovery in patients receiving Sevoflurane or Isoflurane for maintenance in pediatric patients undergo tonsillectomy with or without adenoidectomy under Sevoflurane general anesthesia.

## RESEARCH METHOD

### Patients and methods

Single blinded randomized clinical trial was performed on the clinical medical records of 60 children who underwent tonsillectomy and/or adenoidectomy and were admitted to alsader hospital from 16 October 2019 until October 2020

The study was conducted after approval of the scientific council of Anesthesia and intensive care in Iraqi board for medical specializations Anesthesia and intensive care department, and after informed written signed consent was obtained from parents or patients' relatives of participant children

We compared recovery times in patients with American Society of Anesthesiologists physical status I-II receiving sevoflurane or isoflurane for maintenance of anesthesia during surgical procedures between 45 minute and 1 hour in duration. 30 patients received sevoflurane and 30 patients received isoflurane

**Inclusion criteria:**

Children underwent tonsillectomy or adenoidectomy, ASA I-II, aged 5-15years, and Surgical procedures between 45 minute and 1 hour in duration

**Exclusion criteria:**

Those with a history of inhalational anesthesia allergy, Patient refusal (father or mother), ASA III, IV, V, Children with congenital heart disease, and History of behavioral disorder

The data were collected by researcher through full history taking and thorough clinical examination and follow up and the data were reported in previously prepared data collection sheet.

**Study Procedure:**

- All pediatric patients in both group's sevoflurane Group and Isoflurane group were prepared to undergo elective operation. Children in the two groups were given intravenous general anesthesia for the operation.
- Eight hours before the operation, all children were fasted.
- Upon arrival at the operating room, patients were assessed by history, physical examination, chest auscultation, IV cannula was established
- The monitoring device was connected to detect the HR, NIBP and SpO2 of children.
- Administered IV fluid with glucose saline according to body weight
- Patients preoxygenated with 100% oxygen through a face mask before induction
- At time of induction, children were intravenously given propofol 2.5mg /kg and Rocurinum 0.5 mg/kg to facilitate tracheal intubation. for maintenance Children in the sevoflurane group given Sevoflurane 1.3% (2.6), children in Isoflurane group given 1.3% (1.5).8 Isoflurane, Patients received mechanical ventilation, Continuous monitoring for breathing, SPO2, HR, and the end-tidal carbon dioxide partial pressure maintained at 30-38 mmHg.,
- Acetaminophen infusion(15mg/kg) administered intravenously after induction

- The inhalational agent switched off immediately at the end of surgery at this time patient were ventilated manually with 100% oxygen, placed in the lateral decubitus, where done their oral secretions were cleaned up.
- When children had spontaneous breathing, and had spontaneous limb activity, reversal of neuromuscular blocking with neostigmine 0.05mg / kg and atropine 0.01mg /kg
- the tracheal tube was extubated when he or she had a cough and gag reflex, swallowing, purposeful movements
- When children had stable vital signs, they were sent to PACU

**Outcome measures:**

1. Following timings were recorded; time of surgery (operation time), (Anesthesia time) time from the start of induction till the time of turning-off inhalational agent) (Time of giving reversal agent), (extubation time), (time of discharge to PACU) and (time spent at PACU room).
2. The incidence of Nausea and vomiting and the incidence of laryngeal spasm

**Statistical analysis:**

Data of the 60 patients in both groups were managed and analyzed using Microsoft Office Excel program as a database sheet and the SPSS software version 26 as statistical package. Variables were presented as frequencies, percentage, mean standard deviation and standard error accordingly. All scale variables were tested for normal statistical distribution; all variables did not follow the normal statistical distribution; hence non-parametric tests were applied in comparisons. Mann-Whitney U test used to compare both studied groups in all scale parameters including the age, weight, duration of anesthesia, duration of surgery, respiratory rate, pulse rate, oxygen saturation and all-time parameters. Chi-square test used to compare frequencies of sex, age groups, Type of Surgery, Spasm and nausea & vomiting. Pearson's and Spearman's bivariate correlation tests used accordingly to assess the effect of other (independent) variables on the changes in all studied parameters the correlation coefficient (R) values were calculated for each parameter. Level of significance (P. value) of 0.05 or less considered significant.

**DATA ANALYSIS**

There were 60 patients enrolled in this two-arm clinical trial with 30 patients at each arm, namely, Sevoflurane and Isoflurane groups. Baseline characteristics of the studied groups were almost matched with no significant differences in age, sex, weight or Type of Surgery performed, in all comparisons, P. value > 0.05. From other point of view, the mean age of the patients was 9.7 ± 3.2 and 10.2 ± 3.3 years in Sevoflurane and Isoflurane groups, respectively, the age ranged 5-15 years in both groups. Females were dominant in both groups in a ratio of 2.75 to one in Sevoflurane group and 2.0 to one in Isoflurane group. Mean weight was 3.1.1 ± 8.6 in Sevoflurane group and 31.5 ± 7.9 kg to one in Isoflurane group, (Table 1).

As shown in table 2, duration of surgery and anesthesia were insignificantly different between both groups; it was 40.1 ± 11 minutes and 42.7± 8.4 minutes in Sevoflurane and Isoflurane, respectively, (P. value > 0.05). The mean duration of anesthesia was 49.8 ± 11.4 minutes in Sevoflurane and 51.4± 8.5 minutes in Isoflurane groups with no significant difference, (P. value > 0.05).

Comparison incident laryngeal spasm and Nausea and vomiting among the studied groups revealed a significant more frequent laryngospasm in Sevoflurane group, (26.7%) compared to only 2 (6.7%) in the Isoflurane group, (P= 0.038, significant). No significant difference in the incidence of nausea and vomiting, (P>0.05), (Table 3)

The mean score at the time of switching off Inhalational agent (zero time) was not significantly different between both groups, (P>0.05). At the subsequent time, it was elevated in both groups but the difference still statistically in significant at the subsequent three checkpoints, (P> 0.05) (Table 4)

No significant variation was found in the pulse rate, respiratory rate, or oxygen saturation rate between both groups at different time of assessment, in all comparisons, (P>0.5, not significant), (Tables 5, 6 & 7). As demonstrated in Table 8, the mean time from switching off inhalational agent to giving reversal agent(0-AD) was significantly longer in Sevoflurane than Isoflurane group; 10.1 ± 5.2 vs. 5.6 ± 3.1, respectively, (P. value < 0.05). Conversely, the differences in the time from giving reversal agent to extubation (AD-E), time from extubation to discharge to post anesthesia care unit (ED) and Time from discharge at post anesthesia care unit to ward (D-D) were statistically insignificant, (P>0.05).

Furthermore, the changes in all parameters at different assessment points were not affected by patients characteristics, type of surgery, duration of surgery , duration of anesthesia and other variables , the effect of these variables assessed using the bivariate correlation analysis and correlation coefficient ( R ) values using Pearson's and Spearman's correlation tests accordingly, results of the correlation analysis revealed that the changes in the studied parameters did not affected by these variables, (P>0.05), (Table 9)

**Table 1. Baseline characteristics of the studied groups**

| | | Group | | | | P. value |
|---|---|---|---|---|---|---|
| | | Sevoflurane (n= 30) | | Isoflurane (n= 30) | | |
| | | No. | % | No. | % | |
| Age (year) | ≤ 5 | 3 | 10.0 | 2 | 6.7 | 0.627 ns |
| | 6 – 10 | 15 | 50.0 | 12 | 40.0 | |
| | 11 – 15 | 12 | 40.0 | 16 | 53.3 | |
| | Mean (SD*) | 9.7 (3.2) | | 10.2 (3.3) | | 0.531 ns |
| Sex | Male | 8 | 26.7 | 10 | 33.3 | 0.778 ns |
| | Female | 22 | 73.3 | 20 | 66.7 | |
| Type of Surgery | Adenoidectomy | 9 | 30.0 | 7 | 23.3 | 0.347 ns |
| | Tonsillectomy | 12 | 40.0 | 8 | 26.7 | |
| | Tonsillectomy & Adenoidectomy | 9 | 30.0 | 15 | 50.0 | |
| Weight (kg) (mean (SD) | | 31.1 (8.6) | | 31.5 (7.9) | | 0.841 ns |
| SD: standard deviation of the mean | | | | | | |

**Table 2. Comparison of Durations of surgery and Anesthesia among the studied groups**

| Variable | Group | | | | P. value |
|---|---|---|---|---|---|
| | Sevoflurane (n= 30) | | Isoflurane (n= 30) | | |
| | Mean | SD | Mean | SD | |
| Duration of surgery (min) | 40.1 | 11.0 | 42.7 | 8.4 | 0.481 ns |
| Duration of anesthesia (min) | 49.8 | 11.4 | 51.4 | 8.5 | 0.557 Ns |

**Table 3. Comparison incident laryngeal spasm, Nausea, and vomiting Among the studied groups**

| | | Group | | | | P. value |
|---|---|---|---|---|---|---|
| | | Sevoflurane (n= 30) | | Isoflurane (n= 30) | | |
| | | No. | % | No. | % | |
| Laryngeal spasm | Yes | 8 | 26.7 | 2 | 6.7 | 0.038 sig |
| | No | 22 | 73.3 | 28 | 93.3% | |
| Nausea and vomiting | Yes | 10 | 33.3 | 8 | 26.7 | 0.573 |
| | No | 20 | 66.7 | 22 | 73.3 | Ns |

**Table 4. Comparison of patients' scores at different times among the studied groups**

| | Group | | | | P. value |
|---|---|---|---|---|---|
| | Sevoflurane (n= 30) | | Isoflurane (n= 30) | | |
| | Mean | SD | Mean | SD | |
| Score at switching off Inhalational agent (zero time) | 0.20 | 0.18 | 0.33 | 0.21 | 0.169 ns |
| Score at giving reversal agent | 2.57 | 0.57 | 2.60 | 0.50 | 0.720 ns |
| Score at Extubation | 4.40 | 0.72 | 4.73 | 1.11 | 0.231 ns |
| Score at discharge to Post Anesthesia care unit | 5.21 | 0.85 | 5.46 | 0.82 | 0.251 ns |
| SD: Standard error of the mean, ns: not significant | | | | | |

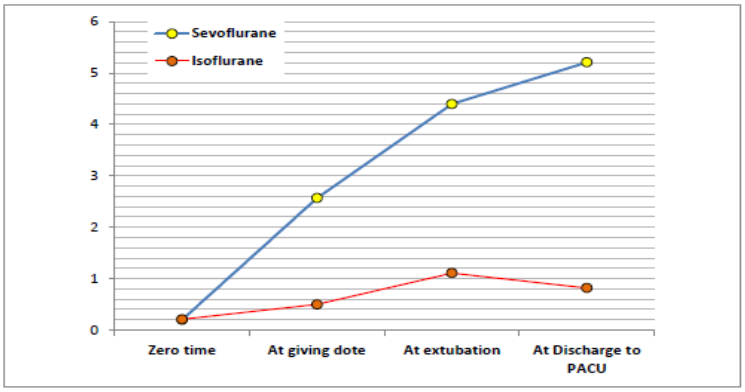


Figure 1. Trend of change in the scores at different measurement time

*PACU: post anesthesia care unit*

**Table 5. Comparison of pulse rate at different times among the studied groups**

| Parameter | Group | | | | P. value |
|---|---|---|---|---|---|
| | Sevoflurane (n= 30) | | Isoflurane (n= 30) | | |
| | Mean | SD | Mean | SD | |
| Perioperative pulse rate (Pulse/min) | 115.9 | 20.3 | 117.0 | 14.3 | 0.795NS |
| Pulse rate at extubation time (Pulse/min) | 117.0 | 15.4 | 113.9 | 14.2 | 0.192 NS |
| Pulse rate at post anesthesia care unit (Pulse/min) | 113.6 | 15.7 | 113.5 | 12.9 | 0.906 NS |

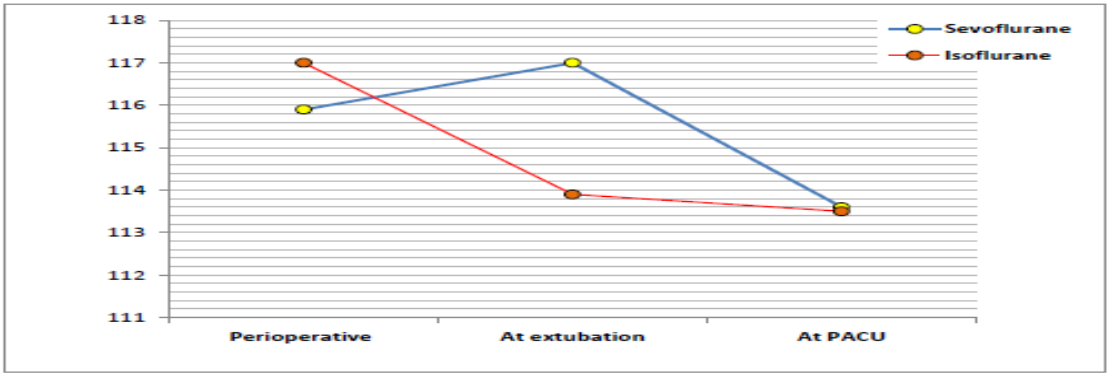


Figure 2. Trend of change in the pulse rate at different measurement time
*PACU: post anesthesia care unit*

**Table 6. Comparison of respiratory rates at different times among the studied groups**

| Parameter | Group | | | | P. value |
|---|---|---|---|---|---|
| | Sevoflurane (n= 30) | | Isoflurane (n= 30) | | |
| | Mean | SD | Mean | SD | |
| Perioperative respiratory rate (breath/min) | 13.6 | 1.4 | 13.3 | 1.0 | 0.287 ns |
| Respiratory rate at extubation time (breath/min) | 14.1 | 2.3 | 13.5 | 1.3 | 0.280 ns |
| Respiratory rate at post anesthesia care unit (breath/min) | 13.7 | 1.7 | 13.3 | 1.2 | 0.576 ns |

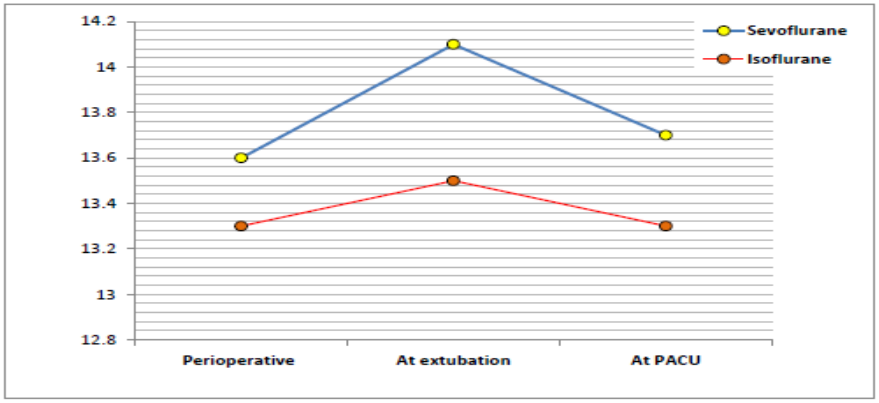


Figure 3. Trend of change in the respiratory rate at different measurement time

*PACU: post anesthesia care unit*

**Table 7. Comparison of Saturation of O2 at different times among the studied groups**

| Parameter | Group | | | | P. value |
|---|---|---|---|---|---|
| | Sevoflurane (n= 30) | | Isoflurane (n= 30) | | |
| | Mean | SD | Mean | SD | |
| Perioperative Saturation of O2 (%) | 99.8 | 0.4 | 99.7 | 0.6 | 0.457 ns |
| Saturation of O2 at extubation time (%) | 97.2 | 2.5 | 97.9 | 2.1 | 0.277 ns |
| Saturation of O2 at post anesthesia care unit (%) | 97.8 | 1.6 | 97.7 | 1.4 | 0.721 ns |

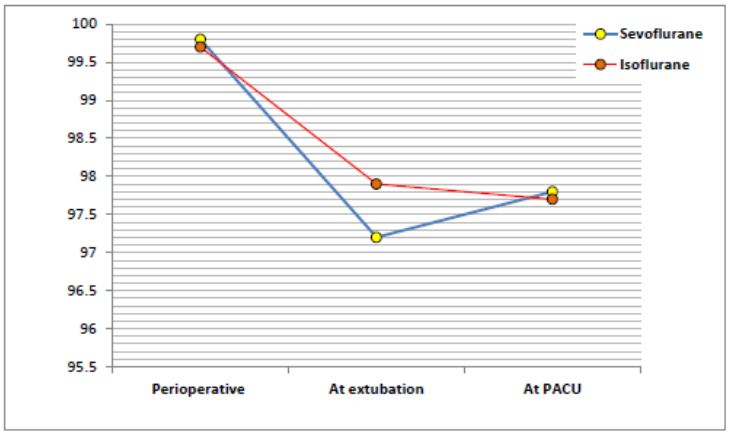


Figure 4. Trend of change in the Saturation of O2 at different measurement time

*PACU: post anesthesia care unit*

**Table 8. Comparison of time from switching off inhalational anesthesia, giving reversal agent, extubation, discharge to post anesthesia care unit to the discharge to ward**

| | Group | | | | P. value |
|---|---|---|---|---|---|
| | Sevoflurane (n= 30) | | Isoflurane (n= 30) | | |
| | Mean | SD | Mean | SD | |
| Time from switching off inhalational agent to reversal agent(0-AD) | 10.1 | 5.2 | 5.6 | 3.1 | 0.002 sig |
| Time from reversal agent to extubation (AD-E) | 2.9 | 1.6 | 2.9 | 1.6 | NS |
| Time from extubation to discharge to post anesthesia care unit (ED) | 3.7 | 2.4 | 4.7 | 2.8 | 0.647 NS |
| Time from discharge at post anesthesia care unit to ward (D-D) | 13.1 | 4.6 | 12.4 | 5.2 | 0.380 NS |

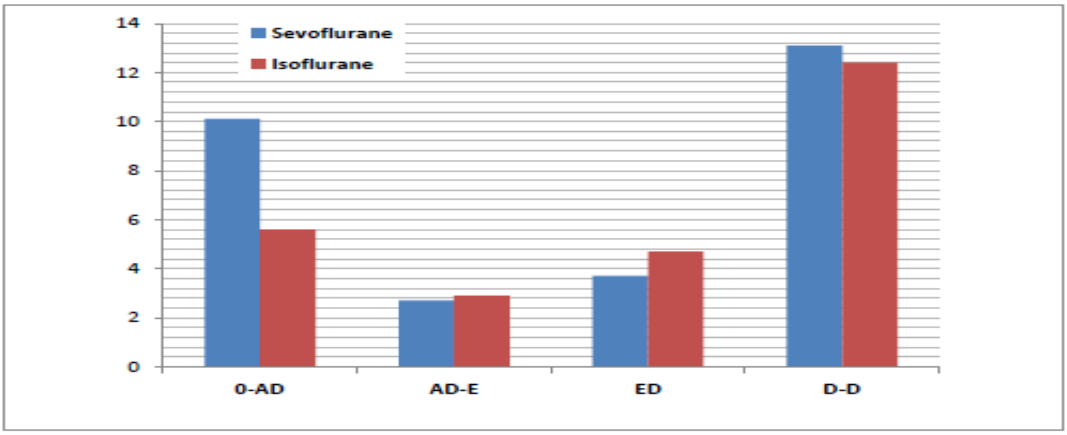


Figure 5. Bar chart showing time from switching off inhalational anesthesia (0-AD), giving antidote (AD-E), extubation to discharge (ED), discharge to post anesthesia care unit to the discharge to ward (D-D)

**Table 9. Matrix of Correlation between independent variables and changes in scores, vital signs and timing**

| Variable | Statistics | Change in score | Change in respiratory rate | Change in pulse rate | Change in Saturation of O2 | Change in Time |
|---|---|---|---|---|---|---|
| Age | R | 0.104 | 0.118 | 0.183 | 0.088 | 0.184 |
| | P. value | 0.428 | 0.160 | 0.161 | 0.504 | 0.159 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Gender | R | 0.094 | 0.027 | 0.160 | 0.095 | 0.189 |
| | P. value | 0.475 | 0.836 | 0.222 | 0.471 | 0.147 |
| Weight (kg) | R | 0.223 | 0.130 | 0.105 | 0.125 | 121 |
| | P. value | 0.089 | 0.321 | 0.427 | 0.341 | 0.130 |
| Duration of surgery | R | 0.168 | 0.057 | 0.11 | 0.002 | 0.003 |
| | P. value | 0.200 | 0.667 | 0.460 | 0.988 | 0.980 |
| Type of Surgery | R | 0.003 | 0.127 | 0.015 | 0.030 | 0.109 |
| | P. value | 0.981 | 0.333 | 0.908 | 0.823 | 0.406 |
| Duration of anesthesia | R | 0.112 | 0.111 | 0.033 | 0.084 | 0.102 |
| | P. value | 0.392 | 0.397 | 0.620 | 0.523 | 0.438 |
| Spasm | R | 0.121 | 0.135 | 0.033 | 0.080 | 0.171 |
| | P. value | 0.358 | 0.304 | 0.801 | 0.544 | 0.192 |
| Nausea and vomiting | R | 0.088 | 0.066 | 0.140 | 0.078 | 0.04 |
| | P. value | 0.452 | 0.617 | 0.285 | 0.554 | 0.545 |

## DISCUSSION

The blood-gas partition coefficient of sevoflurane is lesser than that of isoflurane or other volatile anesthetics with the exception of deflurane,31.32.33 this property should permit rapid induction of and emergence from anesthesia.so we will discuss the recovery between two groups the less soluble sevoflurane, and the more soluble Isoflurane.)

In our result the mean time from switching off inhalational agent to giving the reversal agent(0-AD) was significantly longer in Sevoflurane than Isoflurane group, (P. value < 0.05).

Our study and result aligned with this study 34 by C L Chiu et al. that found the recovery time was faster in the isoflurane group than sevoflurane

In other study by Morio M et al.35in a multi-hospital clinical study in Japan, comparing sevoflurane anesthesia with enflurane anesthesia, showed that emergence from sevoflurane anesthesia is not

faster than enflurane anesthesia. Saito Set al36 in his study on Japanese patients also showed that emergence from sevoflurane anesthesia is not faster than enflurane anesthesia. They suggested that although the rapidity of recovery is partly due to low blood gas partition coefficient, solubility of volatile anesthetics in the tissue especially the brain might also have a strong influence. The lower tissue solubility mediates a more rapid recovery by two mechanisms37. First, the brain time constant will be shorter. Second, the elimination from the body will be more rapid. The tissue/blood partition coefficient of sevoflurane (1.7)37 has been shown to be similar to enflurane (1.7)36 but higher than isoflurane (1.57)37, this may explain the delayed emergence of patients receiving sevoflurane anesthesia as compared to isoflurane anesthesia. We postulate that the tissue/blood solubility is a more important factor than blood gas solubility in predicting speed of recovery when the duration of anesthesia is short. However further studies would need to be conducted to evaluate this hypothesis

While this study by Joaquin et al.38, and other by Thomas J. et al 39 and Dinesh et al.40 approves more rapid emergence with sevoflurane than with isoflurane p value was significant

other study found isoflurane rapid than sevoflurane using the same MAC41 done by Darrell W et al., the study, demonstrated a significant difference in the apparent potency of rocuronium during anesthesia of sevoflurane compared with isoflurane. In addition, the duration of action of a bolus dose of rocuronium 0.6 mg/kg was significantly prolonged with sevoflurane suggest that, under usual clinical conditions, the effects of rocuronium are prolonged during sevoflurane anesthesia. The prolongation of the effect of rocuronium during sevoflurane anesthesia is probably caused by a faster and more complete equilibrium among the end-tidal, blood, and muscle concentrations of sevoflurane because of its smaller muscle-gas partition coefficient, resulting in an increased duration of action and slower recovery,41

Another possible reason for the difference observed between the sevoflurane and isoflurane groups is the effect of the two anesthetics on hepatic blood flow, because amino steroid muscle relaxants are taken up by the liver. However, the evidence about such effects is not conclusive. Kobayashi et al.42 suggested that isoflurane increases the hepatic blood flow, whereas it remains unchanged with sevoflurane, the study by Kanaya et al.43

In the same study Dinesh et al.40 there is a statistically significant difference in the discharge time after extubation between the isoflurane and sevoflurane groups with earlier discharge in the sevoflurane group compared to isoflurane group to PACU, However, this earlier discharge did not translate into earlier discharge from PACU for the sevoflurane group (P value=0.08.40

While in our study no significant difference in both times after extubation and in PACU

-HR and RR, spo2 were Comparison between the two groups did not reveal a statistically significant difference, P value >0.05.40 similar to our study

Incidence of nausea and vomiting not significant in both groups by study of Thomas J. et al39, Nausea was noted in both the isoflurane and sevoflurane groups all were mild and none required treatment with any antiemetic drugs. 33% and 26%, while the study of C L Chiu et al. Incidence was 10%34

Vomiting was not observed in any patients resemble to this study by C L Chiu et al 34

Incidence of laryngeal spasm was significant, more frequent in Sevoflurane group, (26.7%) compared to only 2 (6.7%) in the Isoflurane group, (P= 0.038, significant). Compared to by study Mark H. et al.44 similar results were found

Our different results could have been attributed to the fact that we had a smaller sample. Our sample was set at 60. We considered this enough to identify any clinically significant difference between the agents. However, with a larger sample, some statistical difference might become apparent,

At the end of our research it's better to use good analgesia like opioid 44perioperative or with induction with sevoflurane to decrease the agitation and laryngeal spasm post op. and permit smoother recovery and to decrease early requirement to analgesia post op.

## FINDINGS AND RECOMMENDATIONS

The findings of the study; it can be concluded: that Isoflurane had faster emergence than sevoflurane after switching off the vaporizer More side effects related with sevoflurane if using alone as maintenance agent like agitation, laryngeal spasm, faster requirement for analgesia, prolong recovery Use adjuvant drug with inhalational agent like (midazolam, opioid)

## REFERENCES

1. THOMAS J. EBERT.SAWYER A. NAZE.Inhaled Anesthetics Introduction and Overview. Overview of Current Inhaled Anesthetics Isoflurane. Sevoflurane. Clinical Anesthesia.2017; 18:1184-1205)
2. Strum DP, Eger EI 11. Partition coefficient for sevoflurane in blood, saline, and olive oil. Anesth Analg 1987; 66:654-6.
3. Malviya S, Lerman J. The blood gas solubilities of sevoflurane, isoflurane, halothane and serum constituent concentrations in neonates and adults. Anesthesiology 1990; 72:793-6.
4. Saito S, Goto F, Kadoi Y, Taskahashi T, Fujita T, Mogi K. Comparative clinical study of induction and emergence time in sevoflurane and enflurane anesthesia. Acta Anesthesiol Scand 1989;33:389-90.
5. Ryan SM, Nielsen CJ. Global warming potential of inhaled anesthetics: application to clinical use. Anesth Analg. 2010;111(1):92–98.
6. Sulbaek Andersen MP, Nielsen OJ, Karpichev B, et al. Atmospheric chemistry of 1250 isoflurane, desflurane, and sevoflurane: kinetics and mechanisms of reactions with chlorine atoms and OH radicals and global warming potentials. J Phys Chem A. 2012;116(24):5806–5820.
7. Sulbaek Andersen MP, Sander SP, Nielsen OJ, et al. Inhalation anaesthetics and climate change. Br J Anaesth. 2010;105(6):760–76
8. Stachnik J. Inhaled anesthetic agents. Am J Health-Syst Pharm 2006;63:623-34
9. Ebert TJ, Muzi M, Lopatka CW. Neurocirculatory responses to sevoflurane in humans: a comparison to desflurane. Anesthesiology. 1995;83:88–95.
10. Malan TP Jr, DiNardo JA, Isner RJ, et al. Cardiovascular effects of sevoflurane compared with those of isoflurane in volunteers. Anesthesiology. 1995; 83:918– 928.
11. Weiskopf RB, Cahalan MK, Eger EI, II, et al. Cardiovascular actions of desflurane in normocarbic volunteers. Anesth Analg. 1991;73:143–156.
12. Stevens WC, Cromwell TH, Halsey MJ, et al. The cardiovascular effects of a new inhalation anesthetic, Forane, in human volunteers at a constant arterial carbon dioxide tension. Anesthesiology. 1971;35:8–16.
13. Ebert TJ, Kampine JP. Nitrous oxide augments sympathetic outflow: direct evidence from human peroneal nerve recordings. Anesth Analg. 1989;69:444–449.
14. Ebert TJ, Muzi M. Sympathetic hyperactivity during desflurane anesthesia in 1242 healthy volunteers: a comparison with isoflurane. Anesthesiology. 1993;79:444– 453.

15. Weiskopf RB, Moore MA, Eger EI, II, et al. Rapid increase in desflurane concentration is associated with greater transient cardiovascular stimulation than with rapid increase in isoflurane concentration in humans. Anesthesiology. 1994;80:1035–1045.

16. Muzi M, Ebert TJ, Hope WG, et al. Site(s) mediating sympathetic activation with desflurane. Anesthesiology. 1996;85:737–747.

17. Yonker-Sell AE, Muzi M, Hope WG, et al. Alfentanil modifies the neurocirculatory responses to desflurane. Anesth Analg. 1996;82:162–166.

18. Pacentine GG, Muzi M, Ebert TJ. Effects of fentanyl on sympathetic activation associated with the administration of desflurane. Anesthesiology. 1995;82:823–831.

19. Devcic A, Muzi M, Ebert TJ. The effects of clonidine on desflurane-mediated sympatho-excitation in humans. Anesth Analg. 1995;80:773–779

20. Andrews JI, Kumar N, van den Brom RH, et al. A large simple randomized trial of rocuronium versus succinylcholine in rapid-sequence induction of anaesthesia along with propofol. Acta Anaesthesiol Scand. 1999;43:4–8

21. Reddy JI, Cooke PJ, Schalkwyk JM, et al. Anaphylaxis is more common with rocuronium and succinylcholine than with atracurium. Anesthesiology. 2015;122:39–45.

22. Sadleir PHM, Clarke RC, Bunning DL, et al. Anaphylaxis to neuromuscular blocking drugs: incidence and cross-reactivity in Western Australia from 2002 to 2011. Br J Anaesth. 2013;110:981–987.

23. SORIN J. BRULL. Neuromuscular Blocking Agents. Individual Nondepolarizing Agents Aminosteroid Compounds.Drug interaction Clinical Anesthesia .2017;21: 1372-1376)

24. Zagólski O: Why do palatine tonsils grow back after partial tonsillectomy in children? Eur Arch Otorhinolaryngol 267: 1613 1617, 2010

25. Anuntaseree W, Rookkapan K, Kuasirikul S and Thongsuksai P:Snoring and obstructive sleep apnea in Thai school-age children: Prevalence and predisposing factors. Pediatr Pulmonol 32: 222-227, 2001

26. Gonzales R, Bartlett JG, Besser RE, Hickner JM, Hoffman JR and Sande MA; Centers for Disease Control and Prevention: Principles of appropriate antibiotic use for treatment of nonspecific upper respiratory tract infections in adults: Background. Ann Emerg Med 37: 698-702, 2001

27. Cullen KA, Hall MJ, Golosinskiy A. Ambulatory surgery in the United States, 2006. Natl Health Stat Rep. 2009(11):1–25

28. LYNNE R. FERRARI • RAYMOND S. PARK. Anesthesia for Otolaryngologic Surgery. Anesthesia for Pediatric Ear, Nose, and Throat Surgery .Tonsillectomy and Adenoidectomy. Anesthetic Management. Clinical Anesthesia.2017;48: 3394-3400)

29. Patel RI1, Hannallah RS, Norden J, et al. Emergence airway complications in children: a comparison of tracheal extubation in awake and deeply anesthetized patients. Anesth Analg. 1991;73(3):266–270.

30. Steward DJ. A simplified scoring system for the post-operative recovery room. Can Anaesth Sot I 1975;22:111-3.

31. Strum DP, Eger EI 11. Partition coefficient for sevoflurane in blood, saline, and olive oil. Anesth Analg 1987;66:654-6.

32. Malviya S, Lerman J. The blood gas solubilities of sevoflurane, isoflurane, halothane and serum constituent concentrations in neonates and adults. Anesthesiology 1990;72:793-6.

33. Eger El. New inhaled anesthetics. Anesthesiology 1994;80:906-22.

34. C L Chiu, Y K Chan, G S Y Ong, A E Delilkan( A Comparison of the Maintenance and Recovery Characteristic of SevofluraneNitrous Oxide Against IsofluraneNitrous Oxide Anaesthesia . Singapore Med J. 2000 Nov;41(11):530-3

35. Morio M. Comparative clinical study on sevoflurane and enflurane. Jpn J Anesthesiol 1987; 36:S50

36. Saito S, Goto F, Kadoi Y, Takahashi T, Fujita T and Mogi K. Comparative clinical study of induction and emergence time in sevoflurane and enflurane anaesthesia. Acta Anaesthesiol Scand 1989; 33:389-90.

37. Yasuda N, Targ AG, Eger EI II. Solubility of I-653, sevoflurane, isoflurane and halothane in human tissues. Anesth Analg 1989; 69:370-3

38. Joaquin Cantillo, M.D., Michael E. Goldberg, M.D., Ghassem E. Larijani, Pharm.D., and Denis Vekeman, CRNA Recovery Parameters after Sevoflurane and Isoflurane Anesthesia. 17 January 2012

39. 3Thomas J. Ebert, MD, PhD ;Brian J. Robinson, PhD ;Toni D. Uhrich, MS ;Arden Mackenthun, PhD ;Philip J. Pichotta, BS Author and Article Information (Recovery from Sevoflurane Anesthesia : A Comparison to Isoflurane and Propofol Anesthesia ) Anesthesiology December 1998, Vol. 89, 1524–1531

40. Dinesh Kumar Sahu, Vinca Kaul, and Reena Parampill ndian J Anaesth. Comparison of isoflurane and sevoflurane in anaesthesia for day care surgeries using classical laryngeal mask airway 2011 Jul-Aug; 55(4): 364–369.

41. Darrell W. Lowry, FFARCSY, Rajinder K. Mirakhur, MD*, Gerard J. McCarthy, MDt, Miriam T. Carroll, FFARCSI*, and Killian C. McCourt, FRCA* *Department of Anaesthetics, The Queen's University of Belfast; and tDepartment of Clinical Anaesthesia, Belfast City Hospital, Belfast, Northern Ireland,( Neuromuscular Effects of Rocuronium During Sevoflurane, Isoflurane, and Intravenous Anesthesia

42. Kobayashi M. The effects of sevoflurane and isoflurane on hepatic blood flow in man. Masui 1994;43:894-7

43. Kanaya N, Nakayama M, Fujita S, Namiki A. Comparison of the effects of sevoflurane, isoflurane and halothane on indocyanine green clearance. Br J Anaesth 1995;74:164-7

44. Sevoflurane Versus Isoflurane: Induction and Recovery Characteristics with Single-Breath Inhaled Inductions of Anesthesia Mark H. Sloan, MD, Pattilyn F. Conard, MA, CRNA, Peter K. Karsunky, MD, and Jeffrey B.