

## Comparison between isoflurane and sevoflurane in inhalation anesthesia: a prospective study

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### HOW TO CITE THIS

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**Abstract:** Inhalation of a gas anesthetic produces rapid induction of anesthesia without the need for intravenous drugs. Although it is specifically useful for patients who are afraid of injections or if their intravenous access is difficult, single-breath induction may also allow patients to wake up more quickly than intravenous induction drugs. The object of this study is to compare isoflurane and sevoflurane during inhalation in Libyan patients undergoing surgery in terms of side effects like blood pressure and heart rate changes and complications. Seventy- five patients were recruited in this study from different hospitals in Benghazi City, Libya (January to March 2022) including Aljalaa Hospital and Alatfal Hospital, and data including side effects and complications were collected through data collection. Surgeries that used isoflurane, or sevoflurane or both inhalation gases for anesthesia were included in our data. While the surgeries that did not use any of these inhalation gases were excluded from our data. When we compared the side effects of using isoflurane with sevoflurane according to the age group, we found that hypotension is the most common side effect compared to the use of isoflurane in our adult population (28.6%) and in pediatrics (14.3%) but there was a low incidence of other side effects related to sevoflurane administration. Regarding to side effects related to the use of sevoflurane according to the age groups, 16 adult Libyan patients experienced no side effects (61.5%) compared to 10 children (38.5%). It can be concluded that both isoflurane and sevoflurane are suitable for daycare anesthesia. Sevoflurane might be an ideal drug for single-breath inhaled induction of anesthesia due to it has fewer side effects and complications.

### Introduction

For more than 150 years, inhalational anesthesia has been used in general anesthesia techniques induction and maintenance [1]. The inhalation induction of general anesthesia is a common procedure. In modern human medicine, isoflurane and sevoflurane are often used an inhalation anesthetic [2]. Induction with isoflurane in oxygen or in combination with oxygen-nitrous oxide mixtures may produce side effects such as cough, and difficulty in breathing [3]. The level of blood pressure during maintenance is an inverse function of isoflurane concentration in the absence of other complicating problems [4, 12]. Volatile anaesthetics are commonly used in patients for surgery and imaging studies. However, prolonged exposure to isoflurane in patients has been

shown to cause side effects, raising concerns about its safety in general anaesthesia [5, 6]. Sevoflurane is becoming a more popular alternative to isoflurane, but its cytotoxic effects have not been compared. This study was conducted to compare isoflurane and sevoflurane during inhalation in Libyan patients undergoing surgery in terms of side effects like blood pressure and heart rate changes and complications in Benghazi City.

## Materials and methods

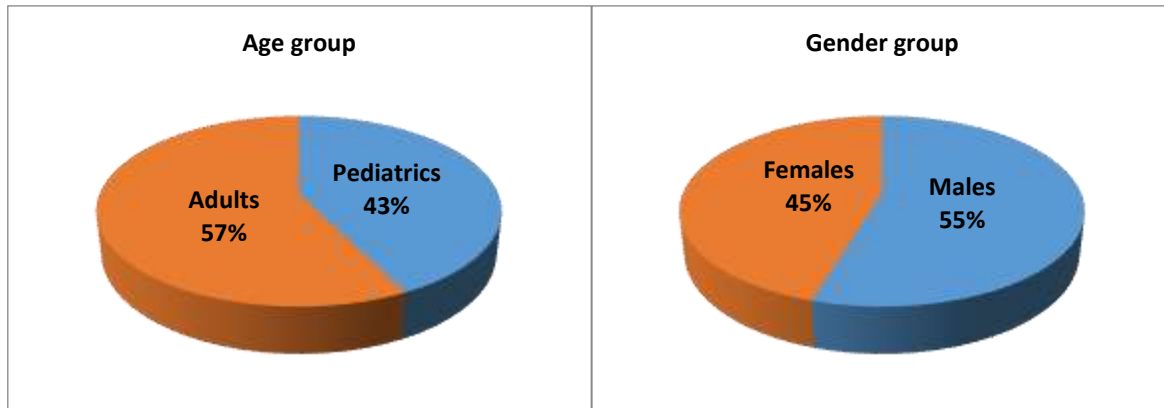
This prospective descriptive study was done on randomly selected patients. This study included 75 Libyan patients (35 females and 40 males) aged from two months to 65 years old. Data was collected from different hospitals in Benghazi City including Aljalaa Hospital and Alاتف Hospital which are scheduled for emergency, orthopedic and elective surgery. The collection of data was from 16<sup>th</sup> January 2022 to 09<sup>th</sup> March 2022. The study was approved by the Faculty of Medical Technology, University of Benghazi, Libya (12/2021).

The patients were randomly selected and divided into three groups of inhalation gases. Forty-eight patients received inhalation of anesthesia using sevoflurane (group S), twenty-one patients received inhalation anesthesia using isoflurane (group I) and six patients received isoflurane and sevoflurane (group B). All the groups received inhalation gases for induction and maintenance. Then, the patients were brought to the operating room, connected to routine monitoring equipment, and primed with the anesthesia machine, 02.0% sevoflurane or 1.2% isoflurane in oxygen mixture, then increased or decreased according to the clinical assessment of the depth of anesthesia and to maintain blood pressure. Pre-anesthetic checkup was performed before surgery (complete blood count, electrocardiograph, blood sugar, liver function test and renal function test). All the patients were fasting from 10-12 hours before scheduled surgery and given atropine/analgesic like fentanyl, a hypnotic drug like propofol or thiopental or ketamine, and a muscle relaxant like atracurium, or esmerone, EET or LMA was inserted. An observer who is one of the researchers in this study recorded the occurrence and severity of complications during induction and after surgery. The observer also recorded heart rate, oxygen saturation, electrocardiograph and arterial blood pressure, in addition to the occurrence of any complications during emergence as well as the time from discontinuation of anesthetics until patients opened their eyes, responded to verbal commands, and exhibited orientation to person and place. The end-tidal anesthetic concentration was also recorded when patients first opened their eyes. At the end of the surgery, ETT or LMA was removed after eye and mouth opening. The hemodynamic variables (HR, PB, SPO<sub>2</sub>, and RR) were monitored initially every ten minutes to the end of the surgery. The inclusion criteria were the surgeries that used isoflurane, or sevoflurane, or both inhalation gases for anesthesia were included in our data. The exclusion criteria: the surgeries that did not use any of these inhalation gases were excluded from our data. Data was statistically analyzed by Chi-square using the SPSS package.

## Results and discussion

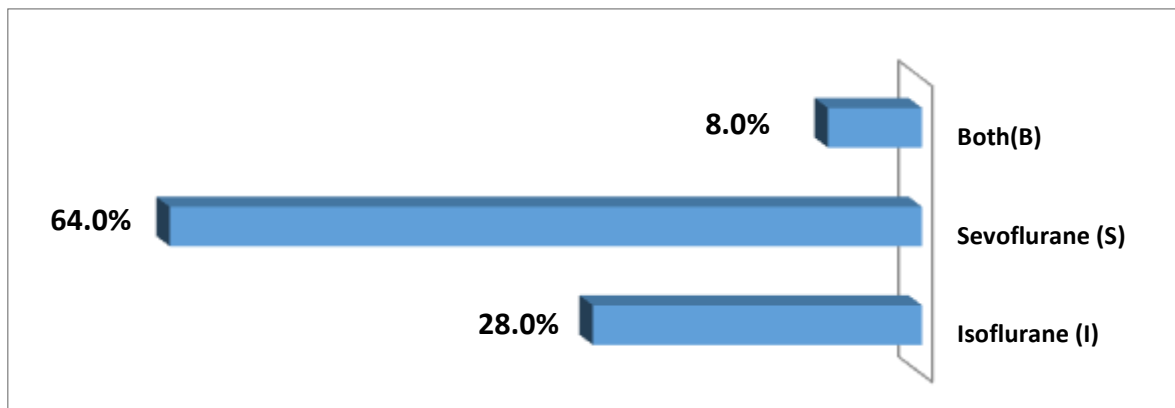
In **Figure 1**, 75 Libyan patients were recruited to participate in this project. We divided our patient population into two categories, pediatrics, whose age range from two months to 18 years old (32 patients, 43.0%) and adults whose age range from 19 years to 65 years old (43 patients, 57.0%). We also, divided the patients according to gender groups; 41 males (55.0%) and 34 females (45.0%) **Figure 2**.

In this study, also, we have also divided the patients into three groups, the first group (I): 21 patients used isoflurane with a percentage of 28.0%, the second group (S): 48 patients used sevoflurane with a percentage of 64.0%, and the third group (B); 6 patients used both isoflurane and sevoflurane with a percentage of 8.0% as shown in **Figure 3**.



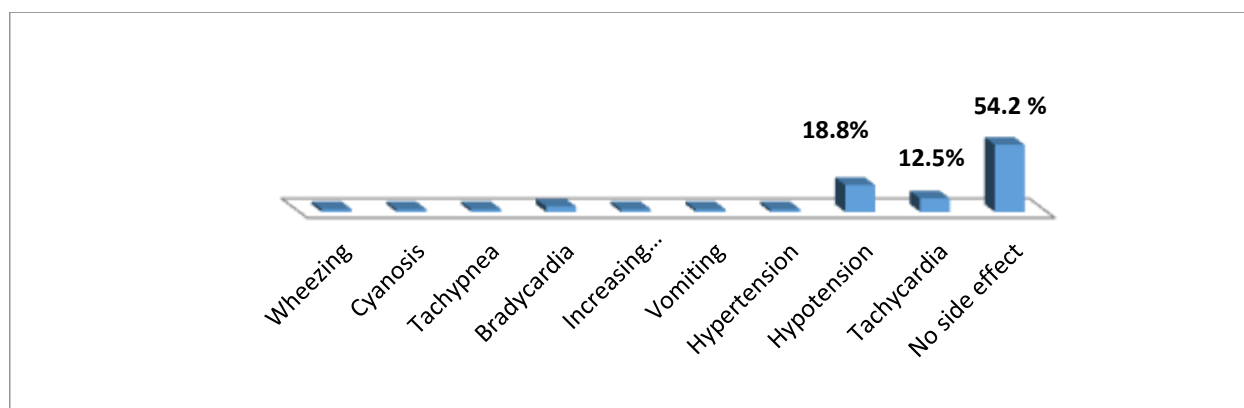
**Figure 1:** distribution according to age

**Figure 2:** Distribution according to gender



**Figure 3:** Percentage of using inhalation gases among the patients

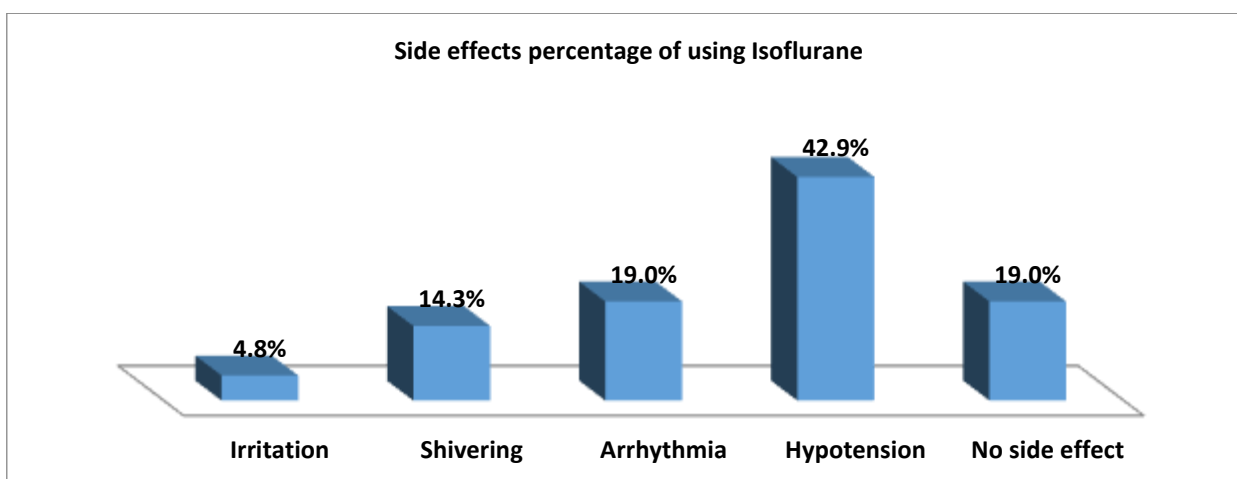
In **Figure 4**, when using sevoflurane 54.2% of the group (S) showed no side effects at all. Concerning the side effects of using sevoflurane, the most frequently occurring side effect is hypotension with a percentage of 18.8%. Comparing the present results to a study done in Japan, in 2016, the purpose of the study was to compare cardiac sympathetic and parasympathetic balance during induction of anesthesia between sevoflurane and isoflurane in combination with nitrous oxide, in which sevoflurane was used in 40 patients, their age ranged from 30 years to 60 years. The results showed that the heart rate decreased during using sevoflurane due to a drop in blood pressure (hypotension) [7, 13]. This agrees with our present study which showed in **Figure 4** that the most common side effect of sevoflurane is hypotension which happened in ten patients of the group (S) with a percentage of 18.8%, also, in a study published by Lake [8]. The same findings supported ours in terms of hypotension reported previously [7, 8].



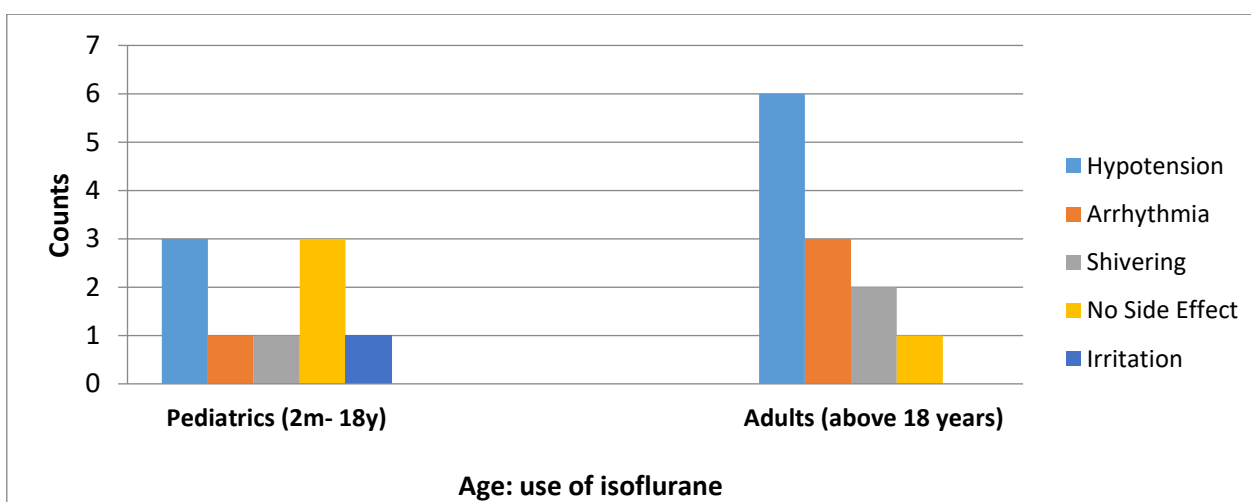
**Figure 4:** Side effects percentage of using sevoflurane among the patients

After using isoflurane, 19.0% of the group (I) showed no side effects at all comparing this to the percentage of the most occurring side effect which is hypotension with the percentage of 42.9%, as shown in **Figure 5**. Comparing this result to the same Japanese study, the heart rate of the patients increased while using isoflurane anesthesia which is not occurring in our study population [7].

In **Figure 6**, when we compared the side effects of using isoflurane with sevoflurane according to the age group, we found that hypotension is the most occurring side effect compared to the use of isoflurane in the adult population (28.6%) and in pediatrics (14.3%), but there was a low incidence of other side effects related to sevoflurane administration. Noting that no bronchospasm has occurred in pediatrics and this may be because isoflurane is very effective in the treatment of bronchospasm especially in children with lung disease, this is supported by a study titled isoflurane for life-threatening bronchospasm, which carried in 2012 and showed that isoflurane led to improvement in life-threatening bronchospasm [4]. The majority of patients in this series developed hypotension, but there was a low incidence of other side effects related to isoflurane administration. Isoflurane appears to be an effective therapy in patients with life-threatening bronchospasm refractory to conventional therapy. Another case report and published in 2018 concluded that isoflurane inhalation could be lifesaving for children with refractory bronchospasm but that it has to be used very carefully owing to different patient responses [2].



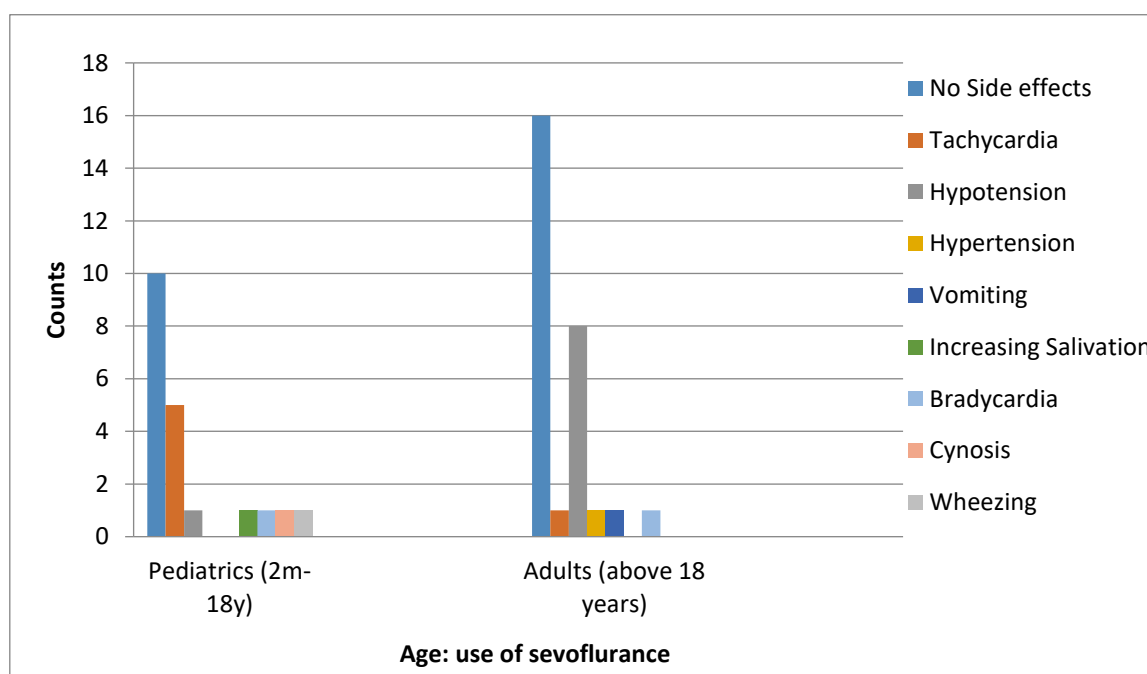
**Figure 5:** Side effects percentage of using isoflurane among the patients



**Figure 6:** Side effects of isoflurane according to age groups

While regarding side effects related to the use of sevoflurane according to the age groups, 16 adult patients experienced no side effects (61.5%) compared to only 10 children (38.5%) and, the most predominant side effect was hypotension with a percentage of 88.9% in adult and tachycardia was the highest in pediatrics with a percentage of 83.3% as shown in **Figure 7**.

Irritation was one of the side effects that had been observed in our population, especially in the pediatric group using isoflurane with a percentage of 11.0%, however, never noticed in the adult group using either sevoflurane or isoflurane. Comparing this to one study done in India concluded that sevoflurane has a little advantage of less airway hyper-reactivity than isoflurane in the adult population [9]. In regard to vomiting and nausea, we have noticed that only 3.6% of adults experienced these side effects while using sevoflurane compared to no single adult patient experienced nausea or vomiting in the isoflurane group. Our results are supported by the previous studies comparing isoflurane with sevoflurane in day surgery, which concluded that sevoflurane is accompanied by a higher incidence of nausea and vomiting in adults [10, 11].



**Figure 7:** Side effects of sevoflurane according to the age difference

In addition to these results, we have found that when we compared the side effects of using isoflurane with sevoflurane in regard to a different gender, males experienced tachycardia (83.3%) more than females (16.7%) in the group (S) and the difference was highly statistically significant with a p-value of 0.003. In contrast, females experienced more hypotension (77.8%) than males (22.2%), noticing that the difference is not significant ( $p=0.122$ ). In the same context, comparing males and females in group (I), we have found that males suffered from low blood pressure and arrhythmia (71.4% and 75.0%, respectively) more than females (28.6% and 25.0%, respectively) and luckily this difference was highly significant ( $p<0.001$ ) as shown in **Table 1**. Sevoflurane has the advantage of quicker emergence, and less airway hypersensitivity, in addition, more nausea and vomiting as side effects happen less frequently with using isoflurane. Isoflurane has more incidence of airway hyperreactivity though milder levels when compared to sevoflurane. Although the incidence of hypotension is less frequent in using isoflurane. Thus, it seems that less hypotension occurred with isoflurane in comparison to sevoflurane. Females who experience hypotension problems are

recommended to use isoflurane as it has a lesser effect than sevoflurane in females in decreasing blood pressure. Males who experience arrhythmia are recommended to use sevoflurane over isoflurane. On the contrary, males with tachycardia are recommended to use isoflurane over sevoflurane.

**Table 1:** Side effects of sevoflurane and isoflurane group according to gender

Groups	Counts	Variables		P value
		<b>Tachycardia</b>		
		Male	Female	
Isoflurane (I)	27	12 (44.44%)	15 (55.55%)	0.624
Sevoflurane (S)	54	45 (83.30%)	09 (16.70%)	<b>0.003</b>
		<b>Hypotension</b>		
		Male	Female	
Isoflurane (I)	27	19 (71.40%)	08 (28.60%)	<b>&lt; 0.001</b>
Sevoflurane (S)	54	12 (22.20%)	42 (77.80%)	0.122
		<b>Arrhythmia</b>		
		Male	Female	
Isoflurane (I)	27	20 (74.0%)	07 (26.0%)	<b>&lt; 0.001</b>
Sevoflurane (S)	54	32 (59.20%)	22 (40.80%)	0.321

**Conclusion:** It can be concluded that sevoflurane and isoflurane are suitable for daycare anesthesia. In pediatrics, sevoflurane is favored over isoflurane.

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**Author contribution:** HAA conceived, designed the study, and collected the data. MZA, RAA & SKA contributed to data analysis & interpretation of data. All authors drafted, revised the manuscript and approved the final version of the manuscript and agreed to be accountable for its contents.

**Conflict of interest:** The authors declare the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

**Ethical issues:** Including plagiarism, informed consent, data fabrication or falsification, and double publication or submission were completely observed by the authors.

**Data availability statement:** The raw data that support the findings of this article are available from the corresponding author upon reasonable request.

**Author declarations:** The authors confirm that all relevant ethical guidelines have been followed and any necessary IRB and/or ethics committee approvals have been obtained.

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