RESEARCH PAPER

Comparative Evaluation of Isoflurane and Sevoflurane on Intraoperative Blood Loss, Hemodynamic Stability, and Postoperative Hemoglobin Changes in Patients Undergoing Ear and Nose Surgery: A Prospective Observational Study

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ABSTRACT

Background

Volatile anesthetic agents play a critical role in maintaining intraoperative stability and influencing surgical field conditions. Isoflurane and sevoflurane are widely used inhalational agents; however, their comparative impact on intraoperative bleeding and hemodynamic stability in ear and nose surgeries remains clinically relevant.

Aim

To compare the effects of isoflurane and sevoflurane on intraoperative blood loss, hemodynamic stability, and perioperative hemoglobin changes in patients undergoing ear and nose surgeries.

Methods

This prospective comparative study included 112 adult patients (ASA I–II) scheduled for elective ear and nose surgeries under general anesthesia. Patients were allocated into two groups: Group I (isoflurane) and Group S (sevoflurane). Heart rate, systolic blood pressure, and diastolic blood pressure were recorded at baseline, after drug administration, and at 5, 15, 30, and 60 minutes intraoperatively. Intraoperative blood loss was measured using suction volume and swab estimation. Preoperative and postoperative hemoglobin levels were recorded. Statistical analysis was performed using independent t-test and chi-square test. A p-value <0.05 was considered statistically significant.

Results

Baseline demographic and ASA distribution were comparable between groups (P > 0.05). No statistically significant differences were observed in heart rate or blood pressure at any intraoperative time point (all P > 0.05). Mean intraoperative blood loss was significantly higher in the isoflurane group (133.3±14.14 ml) compared to the sevoflurane group (121.0±42.42 ml; P = 0.0431). Postoperative hemoglobin levels and total hemoglobin drop showed statistically significant differences between groups (P = 0.0033 and P < 0.0001 respectively).

Conclusion

Both anesthetic agents maintained comparable hemodynamic stability. However, sevoflurane was associated with lower intraoperative blood loss and significant perioperative hemoglobin changes. Anesthetic choice may therefore influence operative field conditions in ear and nose surgeries.

Keywords: Isoflurane; Sevoflurane; Anesthesia, General; Anesthetics, Inhalation; Blood Loss, Surgical; Hemodynamics; Hemoglobin; Otorhinolaryngologic Surgical Procedures; Intraoperative Period; Postoperative Period.

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INTRODUCTION

Balanced anaesthesia represents the cornerstone of contemporary anesthetic practice, integrating hypnosis, analgesia, muscle relaxation, and autonomic stability to provide optimal surgical conditions while minimizing physiological stress responses [1]. The concept emphasizes the rational combination of anesthetic agents to achieve adequate depth of anesthesia with hemodynamic stability and rapid recovery. Over time, advances in volatile anesthetic pharmacology have refined this approach, allowing greater precision in intraoperative management and improved perioperative outcomes.

Volatile anesthetics such as sevoflurane, desflurane, and isoflurane remain widely utilized because of their titratability and predictable pharmacokinetic properties. Their selection can influence airway reactivity, cardiovascular responses, and postoperative recovery patterns. A meta-analysis evaluating sevoflurane versus desflurane demonstrated differences in upper respiratory morbidity among patients undergoing general anesthesia with a laryngeal mask airway, highlighting the clinical relevance of agent selection in airway-sensitive procedures [2]. Similarly, systematic evaluation of adverse respiratory events in ambulatory surgery has shown that anesthetic choice may influence perioperative airway outcomes [3]. These findings are particularly important in ear and nose surgeries, where airway instrumentation and operative field conditions are central to surgical success.

Recovery characteristics represent another critical determinant in selecting inhalational agents. In obese surgical patients, desflurane and sevoflurane have been compared with regard to recovery profiles, demonstrating measurable differences in emergence and early postoperative parameters [4]. Earlier multicenter comparisons of sevoflurane and isoflurane further documented distinctions in maintenance characteristics and recovery timelines, reinforcing the importance of individualized anesthetic selection [5]. The suitability of sevoflurane for adult day-case anesthesia has also been supported by clinical evaluation, emphasizing its favorable pharmacodynamic profile [6].

Understanding the clinical application of these agents requires appreciation of their historical evolution and pharmacologic mechanisms. The development of inhalational anesthesia has progressed from early ether-based techniques to highly refined halogenated agents with improved safety margins and reduced systemic toxicity [7]. In specific surgical contexts such as thyroid surgery, anesthetic management presents unique challenges due to airway considerations and hemodynamic fluctuations, underscoring the broader clinical implications of volatile anesthetic pharmacology [8]. Investigations into alternative inhalational agents, including xenon, have further expanded understanding of safety and efficacy profiles in routine clinical use [9].

At a molecular level, inhaled anesthetics exert their effects through modulation of central nervous system receptors and ion channels, contributing to hypnosis, immobility, and autonomic suppression [10]. Adequate attenuation of adrenergic and cardiovascular responses to surgical incision is a key goal of balanced anesthesia, and the concept of MACBAR has been instrumental in quantifying anesthetic depth necessary to blunt stress responses [11]. Additionally, anesthetic potency varies with physiological factors such as age, as demonstrated in meta-analytic evaluations of minimum alveolar concentration (MAC) across different age groups [12]. These pharmacodynamic considerations are fundamental when tailoring anesthetic plans to specific patient populations.

Textbook foundations continue to emphasize the advantages and limitations of various anesthetic techniques, outlining considerations related to hemodynamic stability, stress response modulation, and recovery characteristics [13]. The benefits and drawbacks of inhalational anesthetics must therefore be evaluated within the broader framework of patient safety and procedural requirements [14]. Contemporary clinical anesthesiology integrates these principles to optimize perioperative outcomes through evidence-based selection of anesthetic agents [15].

Despite extensive comparative research, variability persists in intraoperative hemodynamic responses and surgical field conditions associated with different volatile anesthetics. In surgeries involving the ear and nose, where operative visualization may be influenced by bleeding and hemodynamic fluctuations, anesthetic choice may play a pivotal role. Therefore, systematic evaluation of intraoperative blood loss, cardiovascular stability, and postoperative recovery parameters remains clinically relevant.

The present study was undertaken to compare the effects of isoflurane and sevoflurane on intraoperative bleeding, hemodynamic stability, and postoperative parameters in patients undergoing ear and nose surgery. By integrating pharmacologic principles with clinical outcomes, this investigation aims to contribute to evidence-based anesthetic decision-making in otorhinolaryngologic procedures.

METHODOLOGY

This prospective comparative study was conducted in the Department of Anaesthesiology at a tertiary care centre after obtaining institutional ethical approval and written informed consent from all participants. A total of 112 adult patients scheduled for elective ear and nose surgeries under general anesthesia were included in the study. Patients were allocated into two groups of equal size: Group I received isoflurane for maintenance of anesthesia, and Group S received sevoflurane.

Eligible participants were adults aged 18–65 years with American Society of Anesthesiologists (ASA) physical status I or II. Patients with significant cardiopulmonary disease, coagulopathy, anemia requiring preoperative correction, known hypersensitivity to volatile anesthetics, or those on medications affecting coagulation were excluded. Preoperative evaluation included detailed clinical assessment and baseline laboratory investigations, including hemoglobin estimation.

All patients received standardized premedication. General anesthesia was induced using a uniform induction protocol across both groups. After securing the airway, anesthesia was maintained with the assigned volatile agent in oxygen and nitrous oxide mixture, titrated to achieve adequate anesthetic depth. Intraoperative monitoring included continuous electrocardiography, pulse oximetry, non-invasive blood pressure, and heart rate monitoring. Hemodynamic parameters—heart rate, systolic blood pressure, and diastolic blood pressure—were recorded at baseline, after administration of the anesthetic agent, and at 5, 15, 30, and 60 minutes intraoperatively.

Intraoperative blood loss was measured by quantifying suctioned blood volume after subtracting irrigation fluid and by visual estimation of blood absorbed in surgical swabs. Total intravenous fluids administered were recorded. Hemoglobin levels were measured preoperatively and postoperatively, and total hemoglobin drop was calculated. Postoperative monitoring was continued until recovery from anesthesia.

Data were compiled and analyzed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation, and categorical variables were presented as frequency and percentage. Intergroup comparisons were performed using the independent t-test for continuous variables and the chi-square test for categorical variables. A p value <0.05 was considered statistically significant.

Results :

Table 1: Age Distribution of Study Population

Age Group	**Group I (Isoflurane)**	**Group S (Sevoflurane)**	**P value**
18–45 years	39 (69%)	37 (66%)	
45–65 years	17 (30%)	19 (33%)	0.68

The majority of patients belonged to the **18–45 year age group** in both groups. The age distribution between the two groups was comparable and the difference was **statistically non-significant (p > 0.05)**.

Table 2: Gender Distribution of Study Population

GENDER	**GROUP I (N)**	**GROUP I (%)**	**GROUP S (N)**	**GROUP S (%)**	**P VALUE**	**SIGNIFICANCE**
MALE	32	57 %	27	48 %		
FEMALE	24	42 %	29	51 %	P = .344011	Non-significant

Gender distribution was comparable between both groups. In Group I, 57% were male and 42% were female, while in Group S, 48% were male and 51% were female. The difference was statistically non-significant (P = .344011), confirming no gender imbalance between the study groups.

Table 3: ASA Distribution of Study Population

ASA	**GROUP I (N)**	**GROUP I (%)**	**GROUP S (N)**	**GROUP S (%)**	**P VALUE**	**SIGNIFICANCE**
AS	26	46%	19	33%		

A 1						
ASA 2	30	53%	37	66%	P = .17728	Non-Significant

ASA physical status was similarly distributed in both groups. In Group I, 46% were ASA I and 53% were ASA II, whereas in Group S, 33% were ASA I and 66% were ASA II. The difference was statistically non-significant (P = .17728), demonstrating comparable preoperative clinical status.

Table 4: Mean Heart Rate Distribution in Study Population

Time Point	GROUP I (Mean± SD)	GROUP S (Mean± SD)	P VALUE	SIGNIFICANCE
BASE LINE	83.2± 8.48	76.83±1.41	P = 0.2100	Non-Significant
AFTER DRUG	83.7±11.31	75.5±1.41	P = 0.2100	Non-Significant
5 MINS	79.58±11.31	74.25±1.41	P = 0.2206	Non-Significant
15 MINS	79.8±11.31	73.71 ±4.24	P = 0.2423	Non-Significant
30 MINS	86.5±9.899	72.8±1.414	P = 0.2206	Non-Significant
60 MINS	74.5±15.5	71.6±1.41	P = 0.2206	Non-Significant

The mean heart rate at baseline and at all intraoperative time points (after drug administration, 5 minutes, 15 minutes, 30 minutes, and 60 minutes) showed no statistically significant difference between Group I and Group S (all P > 0.05). This indicates that both isoflurane and sevoflurane maintained comparable heart rate stability intraoperatively.

Table 5: Systolic Blood Pressure Distribution in Study Population

Time Point	GROUP I (Mean± SD)	GROUP S (Mean± SD)	P VALUE	SIGNIFICANCE
BASE LINE	123.5 ± 12.75	123.9 ± 9.89	P = 0.8557	Non-Significant
AFTER DRUG	121.5 ± 12.72	121.92± 9.899	P = 0.8557	Non-Significant
5 MINS	120 ± 12.7	120.9± 9.899	P = 0.8557	Non-Significant
15 MINS	119.5 ± 12.72	119.9± 7.08	P = 0.8404	Non-Significant
30 MINS	118.5 ± 12.70	118.8 ± 7.071	P = 0.8691	Non-Significant
60 MINS	117.1± 12.7	117.3± 5.65	P = 0.9161	Non-Significant

Mean systolic blood pressure values were comparable at baseline and throughout the intraoperative period between both groups. At all measured intervals, the differences were statistically non-significant (P values ranging from 0.8404 to 0.9161). This demonstrates that both anesthetic agents maintained similar systolic blood pressure stability.

Table 6: Diastolic Blood Pressure Distribution in Study Population

Time Point	GROUP I (Mean± SD)	GROUP S (Mean± SD)	P VALUE	SIGNIFICANCE
BASE LINE	78.23±8.48	77.14± 2.12	P=0.6650	Non-Significant
AFTER DRUG	78.03±3.53	76.9± 7.77	P = 0.7725	Non-Significant
5 MINS	77.19±4.94	76.14± 9.192	P =0.7757	Non-Significant
15 MINS	74.9± 3.53	75.53± 2.82	P =0.9603	Non-Significant

30 MINS	75.26± 1.41	75.96± 2.12	P = 0.9605	Non-Significant
60 MINS	73.91±3.53	72.3± 0.707	P = 0.8393	Non-Significant

Mean diastolic blood pressure remained comparable between Group I and Group S at baseline and at all recorded intraoperative intervals. All comparisons were statistically non-significant (P values > 0.05). This suggests similar hemodynamic stability in terms of diastolic pressure with both anesthetic agents.

Table 7: Intra Operative Bleeding Distribution in Study Population (Primary Outcome)

Variable	GROUP I (Mean± SD)	GROUP S (Mean ±SD)	P VALUE	SIGNIFICANCE
Intra Operative Bleeding	133.3±14.14	121.0 ± 42.42	P = 0.0431	Significant

The mean intraoperative blood loss was **133.3 ± 14.14 ml in the isoflurane group and 121.0 ± 42.42 ml in the sevoflurane group**, with the sevoflurane group demonstrating significantly lower blood loss (**p = 0.043**)

Corrected Table 8: Hemoglobin Distribution in Study Population

HEMOGLOBIN	GROUP I (Isoflurane) Mean ± SD	GROUP S (Sevoflurane) Mean ± SD	P VALUE	SIGNIFICANCE
PRE OP	13.0 ± 0.42	13.1 ± 0.42	P = 0.2150	Non-Significant
POST OP	11.9 ± 0.42	12.1 ± 0.42	P = 0.0033	Significant
TOTAL DROP (Hb)	**−1.15 ± 0.70**	**−0.80 ± 0.70**	P < 0.0001	Significant

Preoperative hemoglobin levels were comparable between the two groups (P = 0.2150), indicating similar baseline hematological status. Postoperative hemoglobin levels showed a statistically significant difference between the groups (P = 0.0033). The total hemoglobin reduction was greater in the isoflurane group (−1.15 ± 0.70 g/dL) compared with the sevoflurane group (−0.80 ± 0.70 g/dL), which was statistically significant (P < 0.0001). This finding is consistent with the higher intraoperative blood loss observed in the isoflurane group.

DISCUSSION

This study examined whether the choice of volatile anesthetic influences intraoperative bleeding and hemodynamic behavior in ear and nose surgeries. Baseline comparability was ensured, with no statistically significant differences in age (P = 0.685734), gender (P = 0.344011), or ASA distribution (P = 0.17728), allowing outcome differences to be attributed primarily to anesthetic effects rather than demographic imbalance.

Early anesthetic literature describes predictable systemic effects of inhalational agents administered within therapeutic concentrations [16]. These agents reduce systemic vascular resistance through vasodilation while maintaining myocardial performance. In ENT surgeries, anesthetic techniques are often aimed at achieving **controlled hypotension**, which helps minimize bleeding and improves surgical field visibility. Controlled hypotension typically involves maintaining the **mean arterial pressure (MAP) approximately 20–30% below baseline levels**, thereby reducing capillary bleeding at the surgical site while preserving adequate organ perfusion.

In our cohort, systolic blood pressure at baseline was nearly identical between groups (123.5±12.75 mmHg vs 123.9±9.89 mmHg; P = 0.8557), and this similarity persisted through 60 minutes intraoperatively (all P > 0.05), indicating equivalent macro-hemodynamic control.

Pinnock et al. [17] described balanced anesthesia as blunting sympathetic responses without excessive cardiovascular depression. Our heart rate data reflect this balance, with baseline values of 83.2±8.48 vs 76.83±1.41 (P = 0.2100) and no statistically significant differences during intraoperative measurements. This indicates comparable autonomic modulation between isoflurane and sevoflurane under standardized dosing.

Eger [18] demonstrated that anesthetic potency and MAC influence systemic responses in a concentration-dependent manner. As both groups were titrated to equivalent anesthetic depth, the similar heart rate and blood pressure trends confirm that comparable pharmacodynamic endpoints were achieved.

Lee [19] emphasized that modern volatile anesthetics, when properly titrated, rarely produce clinically meaningful differences in routine cardiovascular parameters. Our findings support this observation, as systolic and diastolic pressures remained statistically non-significant at all time intervals (P values 0.6650–0.9161).

In outpatient anesthesia settings, Jindal et al. [20] reported comparable maintenance profiles between volatile agents regarding hemodynamic trends. The stability observed in our study mirrors these findings, suggesting that differences in bleeding outcomes are unlikely to be mediated by systemic pressure variations.

Dodds [21] noted that intraoperative cardiovascular stability does not always reflect microvascular behavior at the surgical field. This distinction is evident in our results. Despite comparable systolic and diastolic pressures, **intraoperative blood loss differed significantly between the two groups**, with **higher mean blood loss observed in the isoflurane group (133.3 ± 14.14 ml) compared with the sevoflurane group (121.0 ± 42.42 ml)** ($p = 0.043$). These findings suggest that the choice of volatile anesthetic may influence surgical field conditions even when systemic hemodynamic parameters remain similar. Overall, the amount of intraoperative blood loss observed in the present study was relatively low in both groups, indicating effective anesthetic management and surgical technique.

Ahanathapillai [22] reported that anesthetic-induced vasodilation may vary across tissue beds and influence surgical field visibility. Our findings indicate that even with stable systemic blood pressure, localized vascular tone differences may contribute to measurable variations in bleeding.

Pinnock et al. [23] further described subtle differences in peripheral vasodilatory effects among volatile anesthetics. The lower mean blood loss observed with sevoflurane may therefore reflect more favorable modulation of mucosal blood flow during ENT procedures, despite similar systemic hemodynamic readings.

Airway considerations are particularly important in ear and nose surgeries. Keller et al. [24] highlighted the importance of stable anesthetic depth for optimal perioperative airway management. In the present study, the absence of cardiovascular variability indicates adequate depth control in both groups, isolating bleeding as the primary differentiating outcome.

Sng et al. [25] demonstrated that consistent anesthetic delivery contributes to controlled operative conditions. The statistically significant reduction in intraoperative blood loss with sevoflurane suggests that anesthetic selection may subtly optimize surgical field conditions without altering systemic hemodynamics.

Braun et al. [26] reported that variations in anesthetic maintenance strategies may influence perioperative physiological responses beyond routine monitoring parameters. Our findings support this observation, as bleeding volume differed significantly ($P = 0.0431$) despite similar blood pressure readings.

Brain [27] described interactions between anesthetic agents and airway smooth muscle tone during supraglottic airway use. The stable heart rate and blood pressure observed in our cohort indicate that both anesthetics provided adequate autonomic suppression during airway management.

Verghese et al. [28] similarly reported that modern volatile anesthetics can maintain stable intraoperative physiology. Our consistent hemodynamic data support this, as no time-point demonstrated statistical divergence between the groups.

Lopez-Gil et al. [29] emphasized that optimal anesthetic depth contributes to improved surgical conditions. Although anesthetic depth appeared systemically equivalent in our study, the significant difference in bleeding volume suggests that sevoflurane may provide a modest advantage in surgical field clarity during ear and nose procedures.

Hemoglobin analysis further supported the intraoperative bleeding findings. Preoperative hemoglobin values were comparable between the two groups (13 ± 0.424 vs 13.1 ± 0.42; $P = 0.2150$), eliminating baseline anemia as a confounding factor. Postoperative hemoglobin levels were lower in the isoflurane group (11.9 ± 0.42 g/dL) compared with the sevoflurane group (12.1 ± 0.42 g/dL), with the difference being statistically significant ($P = 0.0033$). The overall hemoglobin reduction was also greater in the isoflurane group (−1.15 ± 0.70 g/dL) than in the sevoflurane group (−0.80 ± 0.70 g/dL; $P < 0.0001$). These findings correspond with the higher intraoperative blood loss observed with isoflurane anesthesia and further support the potential advantage of sevoflurane in maintaining a relatively clearer surgical field during ear and nose surgeries.

Collectively, these findings indicate that while both anesthetic agents maintain comparable systemic hemodynamic stability, measurable differences in intraoperative bleeding may occur, potentially due to agent-specific microvascular effects rather than macrocirculatory changes.

Conclusion

Both isoflurane and sevoflurane maintained comparable intraoperative hemodynamic stability without significant differences in heart rate or blood pressure parameters. However, sevoflurane was associated with lower intraoperative blood loss and a smaller perioperative hemoglobin reduction compared with isoflurane. These findings suggest that sevoflurane may provide improved surgical field conditions during ear and nose procedures. Nevertheless, the findings should be interpreted cautiously due to the single-center design and the clinical estimation of blood loss. Larger multicentric studies are required to validate these observations.

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