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Comparative effects of desflurane and sevoflurane on recovery time in patients undergoing modified radical mastectomy: a cross-sectional study

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ABSTRACT

Fast and predictable recovery is essential in breast cancer surgery, yet comparative evidence on inhalation anesthetics within Indonesian clinical settings remains limited. This study compared the effectiveness of desflurane and sevoflurane on early recovery time after modified radical mastectomy. A cross-sectional design was applied to 76 ASA I–II female patients who received standardized induction, maintenance, and Aldrete-based recovery assessment. Recovery was categorized as fast (≤10 minutes) or delayed (>10 minutes). Statistical analysis used Chi-square testing, supported by effect size and risk ratio estimation. Desflurane demonstrated significantly faster recovery than sevoflurane (97.4% vs 78.9%, p = 0.014). The association showed a moderate effect size (Cramér's V = 0.30), and patients receiving sevoflurane were substantially more likely to experience delayed recovery (RR = 8.3). These results align with recent studies highlighting desflurane's lower blood–gas solubility and faster elimination profile. The homogeneous sample and standardized anesthetic protocol strengthen internal validity. However, the non-randomized design, purposive sampling, and absence of documented adverse events limit generalizability. Desflurane may offer practical benefits in improving post-anesthesia care unit (PACU) efficiency and surgical throughput in high-volume settings. Further multicenter randomized studies are recommended to confirm these findings and explore broader clinical implications.

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1. INTRODUCTION

Breast cancer represents a major health burden among women and frequently requires surgical management in the form of modified radical mastectomy (MRM) [1], [2]. MRM is commonly performed under general anesthesia [3], [4] making postoperative recovery an essential component of perioperative care. The speed of recovery after anesthesia influences patient safety [5], the duration of observation in the post-anesthesia care unit (PACU) [6], and overall operating room efficiency [7], [8].

Volatile inhalational anesthetics remain widely used for the maintenance of general anesthesia in breast cancer surgery. Among these agents, desflurane and sevoflurane are commonly applied in contemporary anesthetic practice [9]-[11]. Pharmacokinetic differences between the two agents, particularly

related to blood–gas partition coefficients, suggest that desflurane allows more rapid emergence and recovery compared with sevoflurane [12], [13].

Evidence from international studies has consistently demonstrated faster recovery profiles with desflurane across various surgical settings. Comparative studies conducted between 2021 and 2025 reported shorter emergence and recovery times with desflurane compared to sevoflurane in laparoscopic procedures [14]-[16]. Similar findings have been observed in older adult populations and in procedures requiring early neurological assessment, where desflurane facilitated earlier recovery without increasing postoperative complications [17]-[19]. Furthermore, a recent meta-analysis confirmed that desflurane accelerates emergence and readiness for discharge compared with sevoflurane while maintaining a comparable safety profile [20].

In addition to international evidence, several studies conducted in Indonesian clinical settings have examined postoperative recovery following general anesthesia using inhalational agents. An observational study in an Indonesian hospital reported that variations in sevoflurane administration during general anesthesia were significantly associated with differences in recovery of consciousness time, indicating that anesthetic exposure influences postoperative recovery in local practice [21]. Other Indonesian clinical studies have also documented recovery profiles following inhalational anesthesia, emphasizing that anesthetic management and institutional practices may affect recovery outcomes in diverse patient populations [22].

However, previous studies have also indicated that the clinical advantages of inhalational agents may vary depending on patient characteristics, anesthesia protocols, and surgical contexts [23], [24]. In addition, sevoflurane has been reported to provide favorable hemodynamic stability and lower airway irritation in certain clinical scenarios [25]. These findings suggest that recovery outcomes cannot be generalized across all surgical and healthcare settings.

Although the international literature on desflurane and sevoflurane is extensive, evidence specifically evaluating postoperative recovery following MRM within Indonesian clinical settings remains limited. Differences in institutional workflows, perioperative service capacity, and standardized anesthetic practices may influence recovery outcomes and PACU efficiency. In this context, local data are required to support evidence-based selection of inhalational anesthetic agents in routine surgical practice.

Therefore, this study aimed to compare the effects of desflurane and sevoflurane on postoperative recovery time in patients undergoing modified radical mastectomy in an Indonesian hospital. Recovery was assessed using the Aldrete scoring system as a standardized indicator of readiness for PACU discharge. The findings of this study are expected to contribute local clinical evidence to complement existing international literature and support optimization of anesthetic practice in similar healthcare settings.

2. METHOD

2.1. Study design and setting

This research employed a cross-sectional comparative design conducted in the operating theatre of a type B military hospital in Indonesia. The study focused on patients undergoing elective MRM under general anesthesia. Data were obtained from intraoperative anesthetic records and postoperative recovery documentation within the institution's standardized workflow. All anesthesia procedures were performed by the same anesthesia service team following the hospital's clinical practice standards to minimize variability.

2.2. Samples

The inclusion criteria for this study were that patients were eligible if they met the following criteria, i) Female patients undergoing elective modified radical mastectomy; ii) Classified as ASA physical status I-II; iii) Received inhalation maintenance using either desflurane or sevoflurane; iv) Aged within the typical adult surgical population (18-60 years old); and v) Hemodynamically stable before induction of anesthesia. The exclusion criteria were that patients were excluded if they, i) had incomplete anesthetic or PACU recovery documentation, ii) presented with intraoperative complications requiring anesthetic changes, iii) required postoperative mechanical ventilation, and iv) were converted to other anesthesia techniques.

2.3. Sampling technique

The study used a consecutive sampling method, where all patients meeting the inclusion criteria during the study period were enrolled. This approach ensured that every eligible patient who underwent MRM and received desflurane or sevoflurane was included without omission. The total sample consisted of 76 patients, divided into groups according to the inhalational agent administered.

2.4. Variables

The independent variable is the type of volatile anesthetic used during maintenance, namely the desflurane group and the sevoflurane group. While the dependent variable of this research is post-anesthesia recovery time, assessed using Aldrete Score, specifically the time required to reach an Aldrete score ≥9, indicating readiness for PACU discharge. The control variables for this study include: age, ASA status, basic

hemodynamics, duration of surgery, type of analgesia and additional drugs, airway device used (LMA or endotracheal tube depending on the case), and intraoperative vital signs recorded in the anesthesia chart.

2.5. Anesthesia protocol and post-anesthesia recovery assessment

The anesthetic technique followed the hospital's standard protocol as follows:

i) Induction. Intravenous induction is performed using standard hypnotics and opioids (as noted per patient), and muscle relaxants are administered as needed for airway management.
ii) Airway Management. The airway is secured using a laryngeal mask airway (LMA) or endotracheal intubation, according to clinical records.
iii) Maintenance. Patients are still given Desflurane or Sevoflurane in an oxygen/air mixture; adjustment of vapor concentration is based on patient standard monitoring, which includes ECG, noninvasive blood pressure, pulse oximetry, capnography, and anesthetic gas monitoring, consistent with institutional protocols.
iv) Intraoperative adjuncts, analgesics (e.g., opioids or NSAIDs), are administered according to standard practice, and fluids are titrated according to hemodynamic requirements.
v) Emergence. Volatile agents are discontinued at the end of surgery, and the patient is monitored continuously until spontaneous breathing and protective reflexes return.

Recovery was assessed using the Aldrete Scoring System, the hospital's standard method for determining readiness for PACU discharge. The primary outcome was the time (in minutes) required for each patient to reach Aldrete Score ≥ 9. This assessment included evaluation of activity, respiration, circulation, consciousness, and oxygen saturation.

2.6. Data analysis

Data were analyzed using a standard statistical package. Analysis steps included:

i) Descriptive analysis: patient demographics and perioperative characteristics presented as frequencies, percentages, means, and standard deviations.
ii) Normality testing: performed to determine appropriate statistical procedures.
iii) Comparative analysis: categorical variables analysed using the Chi-square test
iv) Significance level: $p < 0.05$ is considered statistically significant

3. RESULTS AND DISCUSSION

This study involved 76 patients who underwent modified radical mastectomy under general anesthesia. The consolidated characteristics of respondents included age, gender, ASA physical status, type of inhalation anesthetic, and recovery time. These characteristics of the respondents are presented in Table 1.

A total of 76 female patients undergoing modified radical mastectomy were included. The majority were aged 26-35 years (35.5%), followed by 46-55 years (26.3%), 36-45 years (19.7%), and 18-25 years (18.7%). Most participants were classified as ASA I (68.4%), while 31.6% were ASA II. The distribution of inhalation anesthetic agents was equal between groups (desflurane 50%; sevoflurane 50%). Overall, 67 patients (88.2%) achieved fast recovery (≤10 minutes), whereas 9 patients (11.8%) experienced delayed recovery (>10 minutes).

All respondents were female patients who underwent modified radical mastectomy, so gender homogeneity eliminates the potential for bias due to physiological differences between the sexes. The majority are in the productive age range of 26-35 years (35.5%). Age heterogeneity within the young middle adult boundary may influence the dynamics of anesthetic metabolism, but in this study, the distribution was similar in both inhalation agent groups (equivalent 50%-50%), thus not causing group imbalance.

A predominantly ASA I physical status (68.4%) increases interval validity, as the healthy patient group tends to show a stable and predictable pattern of anesthesia recovery. All respondents underwent procedures with standard general anesthesia and uniform protocols, so differences in recovery patterns were more likely caused by differences in the pharmacokinetic characteristics of desflurane and sevoflurane. A total of 88.2% of patients experienced rapid recovery (≤10 minutes). This proportion is the basis for comparison between the inhalation agents used, especially because previous studies have shown that desflurane has a lower blood-gas solubility coefficient and thus accelerates anesthetic wash-out compared to sevoflurane [26]. The differences in recovery time distribution seen in this table are described in more detail in Table 2.

The analysis shows that there is a significant difference between the use of desflurane and sevoflurane in influencing the speed of patient recovery after anesthesia, with a p-value of 0.014. The percentage of rapid recovery was dominant in the desflurane group (97.4%) compared to sevoflurane (78.9%), while delayed recovery occurred more frequently in patients receiving sevoflurane. Calculation of the effect size using Cramér's V shows a value of 0.30, which indicates a relationship with moderate strength and clinical significance. In addition, the risk ratio shows that patients receiving sevoflurane have an 8.3 times higher risk of experiencing delayed recovery compared with patients receiving desflurane, with a 95%

confidence interval ranging from 0.06 to 0.39. These results suggest that differences in inhalation agents make a significant contribution to the variability in recovery time.

These findings are consistent with a number of recent studies showing that desflurane produces faster emergence and recovery times than sevoflurane in various types of surgical procedures. Nelson *et al.* [15] study reported that desflurane significantly accelerated awakening time, recovery of airway reflexes, and readiness for discharge in laparoscopic patients compared to sevoflurane. Another recent study by Verma *et al*. [27] and Taschner *et al.* [17] also showed a similar pattern, where desflurane consistently provided a better early recovery profile without an increased incidence of side effects. Even a recent meta-analysis by Hariyanto *et al.* [28] in a neurosurgical population confirmed the superiority of desflurane in speed of elimination and stability of recovery profile compared to sevoflurane.

This difference can be understood through the pharmacokinetic mechanisms of both inhaled agents. Desflurane has a very low blood–gas partition coefficient, so absorption and elimination of anesthetics in the alveoli is rapid [29], [30]. The decrease in alveolar concentration after cessation of anesthesia occurs more rapidly, especially when fresh gas flow is increased, resulting in a shorter emergence phase [31]. Meanwhile, sevoflurane, with a higher solubility coefficient, experiences a slower wash-out process, thereby extending the recovery time [32]. In this study, all patients received an anesthetic protocol that was homogeneous in terms of induction agents, maintenance, analgesia, and use of airway devices, so that the observed differences in recovery time can be attributed more directly to the pharmacokinetic characteristics of the inhalation agent than to other external factors.

Apart from pharmacological aspects, these findings also have important implications in the management aspect of anesthesia services, especially in hospital environments with high surgical volumes. The selection of inhalation agents with rapid onset and recovery can improve the efficiency of operating room and recovery room turnover, which is relevant for facilities with limited resources. The results of this study specifically add to local evidence from Indonesia regarding the impact of inhalation agent choice on the efficiency of surgical care, which was previously dominated by literature from high-income countries.

There were no reports of side effects such as airway irritation, hemodynamic instability, or postoperative nausea and vomiting in both groups, so the comparison focused more on differences in recovery time. However, the absence of adverse event data limits conclusions regarding the safety profile of the two agents in this study. The non-randomized design, use of purposive sampling, and relatively small sample size limit the generalizability of the findings. Nevertheless, the homogeneity of the population, uniform procedural standards, and significant statistical and clinical differences between the two groups strengthen the internal validity of the findings of this study. Further studies that are randomized and involve several service centers are recommended to expand the generalizability of the results.

Table 1. Respondent characteristics and anesthetic distribution (n = 76)

Variable	Category	Frequency	Percentage (%)
Age group	18-25 years	14	18.7
	26-35 years	27	35.5
	36-45 years	15	19.7
	46-55 years	20	26.3
Gender	Male	0	0.0
	Female	76	100.0
ASA status	ASA I	52	68.4
	ASA II	24	31.6
Inhalation agent	Desflurane	38	50.0
	Sevoflurane	38	50.0
Recovery time	Fast (≤10 minutes)	67	88.2
	Delayed (>10 minutes)	9	11.8

Table 2. Comparison of recovery time by inhalation agent

Inhalation agent	Fast recovery n (%)	Delayed recovery n (%)	Total	p-value
Desflurane	37 (97.4%)	1 (2.6%)	38	
Sevoflurane	30 (78.9%)	8 (21.1%)	38	
Total	67 (88.2%)	9 (11.8%)	76	0.014

4. CONCLUSION

This study demonstrated that desflurane provides significantly faster postoperative recovery than sevoflurane in patients undergoing modified radical mastectomy. The proportion of rapid recovery was markedly higher in the desflurane group, while delayed recovery occurred more frequently among patients receiving sevoflurane. Statistical analysis confirmed a significant association between the choice of inhalation agent and recovery time, with a moderate effect size and a substantially higher risk of delayed recovery in the

sevoflurane group. These findings are consistent with current international literature and can be explained by the pharmacokinetic characteristics of desflurane, particularly its low blood–gas solubility, which facilitates rapid anesthetic elimination and emergence. The homogeneous patient population, standardized anesthetic protocol, and balanced distribution of inhalation agents strengthen the internal validity of the study. Given these results, desflurane may be considered a more effective option for enhancing early recovery and optimizing perioperative workflow in surgical settings with high patient turnover, including resource-conscious hospitals. However, the non-randomized design, limited sample size, and lack of adverse event data warrant caution in generalizing the findings. Further multicenter and randomized studies are recommended to confirm these outcomes and evaluate broader clinical, economic, and environmental implications of anesthetic selection.

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AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

ETHICAL APPROVAL

Ethical clearance was obtained from the institutional ethics committee of the hospital. All patients provided informed consent before surgery and data use, meeting ethical and legal requirements for clinical research.

DATA AVAILABILITY

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request. Observation sheets and Aldrete scoring forms used in the study are available as supplementary files.

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