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# Comparison of Sevoflurane Inhalation Anesthesia and Total Intravenous Anesthesia with Propofol in Terms of Postoperative Sore Throat and Nausea/Vomiting in Septorhinoplasty Cases

## Septorinoplasti Olgularında Sevofluran İnhalasyon Anestezisi ve Propofol İle Uygulanan Total İntravenöz Anestezinin Postoperatif Boğaz Ağrısı ve Bulantı-Kusma Açısından Karşılaştırılması

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**ABSTRACT**

**Objective:** The objective of this prospective observational study was to compare the use of inhalation anesthesia with sevoflurane and total intravenous anesthesia with propofol in terms of sore throat and postoperative nausea/vomiting in elective septorhinoplasty cases under general anesthesia.

**Methods:** This study was conducted using the data of 52 participating patients. Following induction of anesthesia, Group 1 (n=26) received sevoflurane inhalation and remifentanil infusion, while Group 2 (n=26) received intravenous propofol and remifentanil infusion. The presence of nausea/vomiting, the presence and severity of sore throat, extubation times, and the number of patients who were given additional analgesics and antiemetics were recorded at the end of operation.

**Results:** Within post-anesthesia care unit, Group 2 had less sore throat at the postoperative 2$^{nd}$, 6$^{th}$, and 12$^{th}$ h (p values, respectively: 0,014; 0,004; 0,015; 0,044. The number of patients receiving additional analgesics in the postoperative period was 19 in Group 1 and 9 in Group 2 (p=0.005). The results of the groups in terms of postoperative nausea/vomiting were similar.

**Conclusion:** In septorhinoplasty operations, total intravenous anesthesia with propofol resulted in less sore throat and reduced postoperative analgesic use compared to inhalation anesthesia with sevoflurane.

**Keywords:** Sore throat, nausea and vomiting, propofol, septorhinoplasty, sevoflurane, TIVA

**ÖZ**

**Amaç:** Bu araştırmanın amacı, genel anestezi uygulanan elektif septorinoplasti vakalarında intraoperatif sevofluran kullanılarak yapılan inhalasyon anestezisi ve propofol ile yapılan total intravenöz anestezinin boğaz ağrısı ve postoperatif bulantı-kusma açısından karşılaştırılmasıdır.

**Yöntem:** Bu prospektif gözlemsel çalışmaya toplam 52 hasta dahil edildi. Anestezi indüksiyonunu takiben Grup 1'e (n=26) sevofluran inhalasyonu ve remifentanil infüzyonu; Grup 2'ye (n=26) ise intravenöz propofol ve remifentanil infüzyonu başlandı. Ameliyat sonunda bulantı-kusma varlığı, boğaz ağrısı varlığı ve şiddeti, ekstubasyon süreleri, ek analjezik ve antiemetik verilen hasta sayısı kaydedildi.

**Bulgular:** Anestezi sonrası bakım ünitesinde, postoperatif 2., 6. ve 12. saatlerde Grup 2'de daha az boğaz ağrısı mevcuttu (p değerleri sırasıyla: 0,014; 0,004; 0,015; 0,044). Postoperatif ek analjezik uygulanan hasta sayısı Grup 1'de 19 iken Grup 2'de 9 olarak tespit edildi (p=0.005). Postoperatif bulantı-kusma açısından gruplar arasında herhangi bir fark olmadığı saptandı.

**Sonuç:** Septorinoplasti operasyonlarında propofol ile yapılan total intravenöz anestezinin sevofluran kullanılarak yapılan inhalasyon anestezisine kıyasla daha az boğaz ağrısı ve postoperatif analjezik kullanımına neden olduğu saptanmıştır.

**Anahtar sözcükler:** Boğaz ağrısı, bulantı ve kusma, propofol, septorinoplasti, sevofluran, TİVA

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## INTRODUCTION

General anesthesia procedures are commonly employed for surgical operations and invasive procedures (1). Septorhinoplasty, one of the most popular surgeries of recent times, is considered the most commonly performed nasal surgery and is mostly performed under general anesthesia. (2). In today's general anesthesia applications, both total intravenous anesthesia (TIVA) with propofol and inhalation anesthesia with sevoflurane are frequently used because of their pharmacological properties (3-5).

The most common complications due to general anesthesia are postoperative sore throat, nausea and vomiting. These complications may lead to significant health problems and economic loss due to the days when the postoperative activity is lost and the discomfort they cause the patient (6). Therefore, reducing and preventing these complications will improve patient comfort and contribute positively to the treatment proces.

Postoperative sore throat is one of the common complication in the postoperative period due to tracheal intubation in general anesthesia patients. The prevalence of postoperative sore throat can vary between 7% and 80%. The risk may increase up to 80%, especially in high-risk patient groups or during certain surgical procedures (7-9). Inflammation and mucosal damage resulting from tracheal intubation are among the causes of postoperative sore throat (7,10). The tracheal intubation, duration of intubation, movement of the tube for various reasons and prolonged duration of anesthesia are considered as risk factors that can cause postoperative sore throat (7,9,11). Although the sore throat is usually mild and transient, it may be prolonged and may significantly impact patient comfort during the postoperative period (12).

Postoperative nausea and vomiting (PONV) is an discomforting situation for the patient and significantly affect patient satisfaction. Postoperative nausea and vomiting may prolong recovery room stays and increase the risk of postoperative complications (8). Various drugs and factors, including anesthetic agents, can increase the incidence of PONV (13, 14). However, the optimal strategy for preventing and reducing PONV is still being discussed. For example, the Fourth Consensus Guidelines for managing ponv, published in 2020, state that the use of inhaled anesthetics is among the anesthetic risk factors. İn addition to the use of propofol for the induction and maintenance of anesthesia, also recommends avoiding volatile anesthetics (14).

Total intravenous anesthesia is defined as a general anesthesia method used as an alternative to inhalation anesthesia. In TIVA, which is an anesthesia method provided by infusion of intravenous (iv) anesthetics, hypnosis, one of the two important components of anesthesia, is usually provided with propofol, and analgesia is provided by administering an opioid analgesic appropriate for infusion (1). Propofol is an intravenous anesthetic with a short duration of action, which is widely used for the induction and maintenance of anesthesia. It has advantages such as rapid effect, rapid recovery, stability, and preventing nausea and vomiting (3,15). It has been reported that propofol has a lower incidence of PONV compared to inhaled anesthetics (15). Some studies in the literature state that the use of propofol in subhypnotic doses has antiemetic effects and has treated properties for chemotherapy-induced vomiting and PONV (16-18).

Sevoflurane is a volatile anesthetic agent with the advantages of rapid induction, easy control of depth of anesthesia, rapid recovery, and limited respiratory depression (3,15,16). Sevoflurane is one of the most commonly used inhalation anesthetics in general anesthesia applications (1,15,19). Sevoflurane, which is highly effective and non-irritating, especially for mask induction, is accepted as the preferred inhalation agent by many anesthetist (16).

The primary aim of this study was to compare the use of propofol-based TIVA and sevoflurane inhalation anesthesia during septorhinoplasty procedures under general anesthesia in terms of sore throat and PONV. The secondary aim was to compare both anesthesia methods in terms of additional analgesic and antiemetic use.

## MATERIAL and METHOD

### Selection of Patients

Our study was conducted at Diyarbakir Gazi Yasargil Training and Research Hospital operating room between October 2020-March 2021 as a prospective observation. After the approval of our hospital's ethics committee (Ethics committee no/date: 551/11.09.2020), the study was initiated. All patients provided written informed consent, and the study was conducted in accordance with the principles outlined in the 2013 Declaration of Helsinki.

During the study period, a total of 52 patients between the ages of 18 and 65, with American Society of Anesthesiologists (ASA) classification I-II, who were scheduled for septorhinoplasty under general anesthesia, were included. Patients who met the specified criteria were excluded from the study: pregnancy, cancer, ASA ≥ III, inability to provide informed consent, body mass index (BMI) >35 kg $m^{-2}$, history of preoperative sore throat, history of motion sickness, difficult intubation (multiple laryngoscopy or intubation attempts), preoperative analgesic use, preoperative nausea and vomiting, preoperative antiemetic medication, history of perioperative complications, history of influenza within the last 2 weeks, and coag-

ulopathy. The septorhinoplasty operations performed by the same surgeon with an open technique were included in the study. It was planned to divide the patients into two groups according to the method of general anesthesia applied: Group S (Sevoflurane) received inhaled sevoflurane and iv remifentanil infusion for maintenance of anesthesia, while Group T (TIVA) received iv propofol and remifentanil infusion.

### General Anesthesia Management

After the patients were taken to the operating room, an 18 G iv cannula was inserted into the vein from the dorsum of the hand. Intravenous infusion of 0.9% NaCl was set at a rate of 10 ml $kg^{-1}$ $h^{-1}$. Throughout the operation, patients were continuously monitored using pulse oximetry, electrocardiography, and non-invasive blood pressure measurements every 5 minutes. Midazolam of 0.02 mg $kg^{-1}$ was intravenously administered for premedication. After preoxygenation with a face mask for three minutes, induction of anesthesia was initiated. Propofol (Propofol-PF® 1%, POLIFARMA Pharmaceuticals, Tekirdag, Turkey) iv 2 mg $kg^{-1}$, rocuronium iv 0.6 mg $kg^{-1}$ and fentanyl iv 1 µg $kg^{-1}$ were administered for induction of anesthesia. The anesthesia device and monitor used in all patients was Dräger Primus (Drager AG, Lübeck, Germany), and the vaporizer used was sevoflurane vaporizer (Dräger Vapor 2000, Lübeck, Germany). The diameter size of the endotracheal tube was determined according to the patient and intubation was performed under direct laryngoscopy. The same anesthesiologist performed intubation in all patients. Intubation failure after two attempts, difficult intubation, or $SpO_2$ below 95% were exclusion criteria. The endotracheal tube cuff of the intubated patients was inflated until no exhalation sound or leakage could be detected. The pressure of endotracheal tube cuff was measured with a pressure gauge and adjusted to 20-30 $cmH_2O$.

After intubation using a cuffed endotracheal tube with an appropriate diameter for the patient (Henan Tuoren Medical Device Ltd, Henan, China), mechanical ventilation process was started by adjusting the oxygen in the airflow to be 50%. Minute ventilation was adjusted to maintain entidal carbon dioxide (EtCO2) between 35 and 45 mmHg. Anesthesia maintenance was performed with sevoflurane (Sevorane® liquid 100%, Abbvie Pharmaceuticals, Istanbul, Turkey) (end-tidal sevoflurane value 1–1.5 minimal alveolar concentration) and remifentanil (Opiva vial®, Tum Ekip Pharmaceuticals Inc., Istanbul, Turkey) iv 0.05-0.2 µg $kg^{-1}$ $min^{-1}$ infusion in Group S, while propofol was continued with 75-100 µg $kg^{-1}$ $min^{-1}$ and remifentanil iv 0.05-0.2 µg $kg^{-1}$ $min^{-1}$ infusion in Group T. Cefazolin iv. 2 gr. was administered for antimicrobial prophylaxis. The anesthesiologist who monitored the patient made appropriate interventions when intraoperative hemodynamic changes occurred.

### Intraoperative Process and Extubation

During the surgical procedure, the operating surgeon infiltrated a local anesthetic agent containing 10 mL of 1% lidocaine and 10 µg $mL^{-1}$ epinephrine into the surgical area, including the nasal septum, nasal concha, columella, and nasal dorsum. This was done to control bleeding and provide pain relief. The septorhinoplasty procedure was performed using an open surgical technique. The bone and cartilage septum was corrected to improve nasal airflow. The dorsal hump was corrected by reshaping both sides of the nose with a lateral osteotomy. After the operation was completed, nasal tamponade was applied with an internal nasal splint made of soft silicone (Unosplint; Genco Medical Devices, İzmir, Turkey). Paracetamol IV 1 g and tramadol hydrochloride iv 1 mg $kg^{-1}$ was given to all patients thirty minutes before the end of the operation for postoperative pain management. For PONV prophylaxis, ondansetron iv 4 mg was given. The anesthetic agents (remifentanil and sevoflurane/propofol) were stopped 10 minutes before the operation was over. Oral aspiration was conducted after the surgery, and all patients received atropine iv 0.01 mg $kg^{-1}$ and neostigmine iv 0.06 mg $kg^{-1}$ for the reversal of neuromuscular block. After spontaneous ventilation and response to verbal commands, tracheal extubation was performed.

### Postoperative Process

After extubation, the patients were monitored and followed up in the recovery room. The patients with no significant postanesthetic complications and with an Aldrete score >9 were transferred to the ward. After the patients were fully conscious, the presence of nausea/vomiting and the severity of sore throat were evaluated. The severity of sore throat was evaluated by visual analog scale (0 no pain, 10 severe pain). The evaluation of sore throat and other postoperative symptoms was initially assessed in the recovery room and subsequently in the ward at specific time intervals: postoperative $2^{nd}$, $6^{th}$, $12^{th}$, and $24^{th}$ hour. The severity of sore throat was categorized into four levels based on the specified qualitative indices: no pain (0), mild pain (1-3), moderate pain (4-7), and severe pain (7-10). Dexketoprofen iv 50 mg was administered to patients with moderate to severe sore throat. In case of PONV, ondansetron iv 4 mg was administered.

### Recorded Data

Demographic and physiological data, including age, gender, BMI, ASA scores, smoking status, mean arterial pressure (MAP) and heart rate (HR) (baseline, pre-induction and post-intubation) were recorded. Intubation time, surgical time, extubation time, and eye-opening time after anesthesia were recorded. Sore throat and nausea/vomiting (in recovery room, in the postoperative $2^{nd}$, $6^{th}$, $12^{th}$, and $24^{th}$ h) were also recorded.

### Statistical Analysis

The sample size was determined using G-Power version 3.1.9.4, considering a two-tailed alpha error of 0.05, a power of 0.80, and an effect size of 0.7. Based on these parameters and the N2/N1 allocation ratio of 1 from a previous study (20), 52 patients were determined as the minimum number required for the study.

SPSS 21.0 for Windows software (SPSS Inc., Chicago, IL, USA) was conducted for statistical analysis of the data. When evaluating the data statistically, numerical data were expressed as mean and standard deviation, while categorical data were presented as frequency and percentage. The chi-square test and Fisher's Exact test were used to compare categorical data between groups, and the results were reported as percentages (%n). The normality of the numerical data was assessed using the Skewness and Kurtosis test. For normally distributed data, Student's t-test was used for statistical comparison between groups. For non-normally distributed data, the Mann-Whitney U test was employed. In all comparisons, $p<0.05$ was considered significant.

## RESULTS

Table I presents the demographic and clinical characteristics of the 52 patients included in the study. The patients were divided into two groups and compared in terms of demographic, clinical and intraoperative characteristics. It was found that the extubation times of the patients in Group T were longer than those in Group S, and the observed difference was determined to be statistically significant ($p<0.001$). However, no statistically significant difference were found between the two groups regarding other characteristics (Table II).

Table III presents a comparison of the groups regarding two factors: the development of postoperative sore throat and the requirement for additional analgesics. When the development of postoperative sore throat is evaluated, Group T had less sore throat in the recovery room, in the postoperative 2$^{nd}$, 6$^{th}$, and 12$^{th}$ h (p values, respectively: 0.014; 0.004; 0.015; 0.044). Furthermore, the proportion of those who did not develop sore throat in Group T at all postoperative hours was higher than expected. Mild and moderate pain was observed to develop more than expected in Group S in the recovery room, in the postoperative 2$^{nd}$, and 6$^{th}$ h (p values: 0.014; 0.004; 0.015, respectively). Group S had less severe sore throat in the postoperative 2$^{nd}$ and 6$^{th}$ h postop (p values, respectively: 0.004; 0.015), and less moderate sore throat in the postoperative 12$^{th}$ h (p=0.044). The number of patients who received dexketoprofen as an additional postoperative analgesic was 19 in Group S and 9 in Group T (p = 0.005).

Table IV provides a comparison between the groups concerning two factors: postoperative PONV and the need for additional antiemetics. The groups did not show any statistically significant difference in terms of nausea/vomiting in the recovery room and in the postoperative 2$^{nd}$, 6$^{th}$, 12$^{th}$ and 24$^{th}$ h. The number of patients added ondansetron postoperatively was equal in both groups (p=1.0).

**Table I:** Comparison of Groups in Terms of Demographic Characteristics

| | Group S (n=26) | Group T (n=26) | p |
|---|---|---|---|
| | Mean ± SD | Mean ± SD | |
| **Age (years)** | 25.50 ± 7.10 | 26.11 ± 6.45 | 0.54 |
| **Body mass index (kg m$^{-2}$)** | 22.63 ± 4.00 | 22.21 ± 3.32 | 0.69 |
| | n (%) | n (%) | p |
| **Sex** | | | |
| Female | 16 (30.7) | 18 (34.6) | 0.77 |
| Male | 10 (19.2) | 8 (15.3) | |
| **ASA** | | | |
| I | 19 (36.5) | 18 (34.6) | 0.76 |
| II | 7 (13.4) | 8 (15.3) | |
| **Smoking** | | | |
| Yes | 7 (13.4) | 8 (15.3) | 0.76 |
| No | 19 (36.5) | 18 (34.6) | |
| **Total** | 26 (50) | 26 (50) | |

**SD:** Standard deviation; **ASA:** American Society of Anesthesiologists.

**Table II:** Comparison of Groups in Terms of Clinical and Intraoperative Characteristics

| | Group S (n=26) | Group T (n=26) | p |
|---|---|---|---|
| | Mean ± SD | Mean ± SD | |
| Time to intubate | 3.69 ± 0.83 | 3.57 ± 0.8 | 0.56 |
| MAP baseline | 74.8 ± 11.6 | 78.7 ± 11.8 | 0.24 |
| MAP before induction | 90.07 ± 12.82 | 87.8 ± 12.14 | 0.51 |
| MAP after intubation | 86.11 ± 14.64 | 81.15 ± 14.78 | 0.23 |
| HR baseline | 78.4 ± 8.3 | 76.0 ± 8.3 | 0.29 |
| HR before induction | 85.96 ± 11.66 | 90.46 ± 13.31 | 0.51 |
| HR after intubation | 101.96 ± 15.71 | 94.88 ± 19.14 | 0.15 |
| Duration of surgery | 61.84 ± 10.73 | 56.34 ± 10.92 | 0.07 |
| Duration of intubation | 66.73 ± 11.29 | 68.76 ± 12.68 | 0.54 |
| Extubation time | 4.61 ± 1.83 | 7.69 ± 2.58 | **<0.001** |
| Eye-opening time | 7.84 ± 3.51 | 8.11 ± 3.78 | 0.76 |

**SD:** Standard deviation; **MAP:** Mean arterial pressure; **HR:** Heart rate.

**Table III:** Comparison of Groups in Terms of Postoperative Sore Throat and Additional Analgesic Requirement

| | Group S (n=26) | Group T (n=26) | p |
|---|---|---|---|
| | n (%) | n (%) | |
| **Sore Throat in recovery room** | | | |
| No | 5 (9.6) | 16 (30.8) | **0.014** |
| Mild | 10 (19.2) | 4 (7.7) | |
| Moderate | 8 (15.4) | 3 (5.8) | |
| Severe | 3 (5.8) | 3 (5.8) | |
| **Sore throat 2nd hour** | | | |
| No | 5 (9.6) | 16 (30.8) | **0.004** |
| Mild | 6 (11.5) | 2 (3.8) | |
| Moderate | 13 (25) | 4 (7.7) | |
| Severe | 2 (3.8) | 4 (7.7) | |
| **Sore throat 6th hour** | | | |
| No | 5 (9.6) | 14 (26.9) | **0.015** |
| Mild | 11 (21.2) | 3 (5.8) | |
| Moderate | 9 (17.3) | 6 (11.5) | |
| Severe | 1 (1.9) | 3 (5.8) | |
| **Sore throat 12th hour** | | | |
| No | 9 (17.3) | 14 (26.9) | **0.044** |
| Mild | 12 (23.1) | 3 (5.8) | |
| Moderate | 3 (5.8) | 7 (13.5) | |
| Severe | 2 (3.8) | 2 (3.8) | |
| **Sore throat 24th hour** | | | |
| No | 10 (19.2) | 15 (28.8) | 0.4 |
| Mild | 9 (17.3) | 4 (7.7) | |
| Moderate | 5 (9.6) | 5 (9.6) | |
| Severe | 2 (3.8) | 2 (3.8) | |
| Total | 26 (50) | 26 (50) | |
| **Postoperative additional analgesic requirement** | 19 (36.5) | 9 (17.3) | **0.005** |

**Table IV:** Comparison of the Groups In Terms of Postoperative Nausea-Vomiting and Additional Antiemetic Requirement

| | Group S (n=26) | Group T (n=26) | p |
|---|---|---|---|
| | n (%) | n (%) | |
| **Nausea/vomiting in recovery room** | | | |
| No | 23 (44.2) | 22 (42.3) | 0.5 |
| Yes | 3 (5.8) | 4 (7.7) | |
| **Nausea/vomiting 2nd hour** | | | |
| No | 24 (46.2) | 23 (44.2) | 0.5 |
| Yes | 2 (3.8) | 3 (5.8) | |
| **Nausea/vomiting 6th hour** | | | |
| No | 25 (48.1) | 25 (48.1) | 0.75 |
| Yes | 1 (1.9) | 1 (1.9) | |
| **Nausea/vomiting 12th hour** | | | |
| No | 26 (50) | 25 (48.1) | 0.5 |
| Yes | 0 (0) | 1 (1.9) | |
| **Nausea/vomiting 24th hour** | | | |
| No | 26 (50) | 25 (48.1) | 0.5 |
| Yes | 0 (0) | 1 (1.9) | |
| **Additional postoperative antiemetic requirement** | 4 (7.69) | 4 (7.69) | 1.0 |
| **Total** | 26 (50) | 26 (50) | |

## DISCUSSION

In this study, we compared intraoperative sevoflurane inhalation anesthesia and TIVA with propofol in terms of sore throat and PONV in elective septorhinoplasty cases under general anesthesia. We observed that sore throat was less frequent in Group T patients, but the results were similar between groups when evaluated in terms of PONV. In parallel with this results, the number of patients who needed additional analgesics for sore throat in the postoperative period was lower in Group T, whereas the number of patients who used additional ondansetron for PONV was the same in both groups.

The reasons for the development of postoperative sore throat in patients under general anesthesia are still unclear. Despite significant advances in tube materials and design, the incidence of sore throat after intubation has not changed since the 1950s (12). Laryngoscopy exerts significant pressure on the paraglottic tissues. Sore throat can be caused by the contact of laryngoscopy with supraglottic structures, endotracheal tube and cuff with infraglottic structures. Laryngoscopy performed by people with little experience and multiple attempts are important risk factors for sore throat. Therapeutic interventions directed at both supraglottic and infraglottic sources of pain have shown some success in reducing pain. Videolaryngoscopy interventions, preoperative use of magnesium lozenges, and ketamine mouthwash have been found to be effective in minimizing postoperative sore throat (12,21-23). In a meta-analysis conducted by Wang et al., they investigated interventions aimed at preventing postoperative sore throat after tracheal intubation and reported that the use of topical medication was not deemed appropriate. However, ketamine, a N-Methyl-D-aspartate (NMDA) receptor antagonist, corticosteroids, nonsteroidal anti-inflammatory drugs and magnesium have been reported to reduce postoperative sore throat (10).

In the literature, there are many studies that have compared iv propofol and sevoflurane in terms of sore throat and PONV in different types of surgery and patient groups in general anesthesia applications (1,3-5,9,15,16,24). In their study in which they examined the sore throat developing after TIVA application, Maruyama et al. found the incidence of sore throat as 50% (25). In this study, the induction of general anesthesia with propofol, fentanyl, and ketamine and the maintenance of anesthesia with the bolus technique can be considered as a disadvantage. In iv techniques, careful titration of these drugs must ensure adequate depth of anesthesia. The intermittent bolus administration of fentanyl may result in unstable states of consciousness during surgery compared to continuous remifentanil infusion (20). Insufficient relaxation or movement due to inadequate depth of anesthesia can also contribute to increased sore throat (9). Furthermore, it was not specified in this study whether iv analgesic agents were administered intraoperatively and postoperatively for pain management. In their prospective study in which they exam-

ined all intubated patients, Levin et al. confirmed that sore throat after tracheal intubation is common (52%) (12). In the same article, the authors found that the presence of nasogastric catheter and decreasing age were factors that increased the sore throat. However, they did not find any relationship between anesthetic drugs and cuff pressure and sore throat. It has been reported that postoperative ketorolac is mostly used in patients with sore throat. Mencke et al. compared sevoflurane inhalation anesthesia and TIVA with propofol and found the incidence of postoperative sore throat to be 10% in the TIVA Group (20). However, they did not compare this incidence in terms of sore throat severity as in our study. There was no mention to the use of analgesics for postoperative pain management. The lower incidence of sore throat in Mencke's study compared to Maruyama and Levin might be attributed to the administration of general anesthesia with propofol and remifentanil (a short-acting potent opioid) and the use of bispectral index (BIS) monitoring to observe the depth of anesthesia. In our study, the incidence of sore throat ranged between 19.2% and 57.6% in Group S and between 23.2% and 34.6% in Group T, considering repeated measurements based on hours. In accordance with the literature, our sore throat rate was lower in Group T. The difference of our study from other studies was that we evaluated sore throat in terms of hours and severity. The increased percentage of sore throat in Group T in the later hours of the postoperative period suggests that the analgesic contribution of propofol decreased with its excretion from the body. The fact that sore throat was observed less in Group T and the percentage of sore throat in the early postoperative period was lower than in the late postoperative period suggests that propofol contributes to this situation with its analgesic and anti-inflammatory effects (26-28). In addition, the use of less additional dexketoprofen in Group T in the postoperative period, which is another result of our study, supports this.

Trauma leading to laryngeal injury can occur during tracheal intubation, tracheal extubation, and head movement during surgery (11). Inadequate anesthesia or neuromuscular blockade can also result in coughing or movement, which can cause damage to the larynx (9). Therefore, in our study, we attempted to standardize the induction of anesthesia and subsequent tracheal intubation to minimize the risk factors for laryngeal injury. The surgeon was also cautious in minimizing head movement during the operation.

In the studies we reviewed on this topic, we identified several limitations, including long operation duration, insufficient information on analgesic use in the postoperative period (4,9,15,20), and inadequate data on the restriction of head movement that may lead to laryngeal trauma (1,7,12,15). In our study, short operation time, restriction of head movements, controlled administration of propofol and remifentanil by iv infusion, and the use of dual analgesics (paracetamol and tramadol) for postoperative analgesia can be considered as factors that reduce the incidence of sore throat.

Park et al. compared the prevalence of sore throat in inhalation anesthesia performed with desflurane and sevoflurane in major orthopedic lower extremity surgery cases undergoing tracheal intubation (7). In the study, it was emphasized that the occurance of postoperative sore throat in the sevoflurane group was less than in the desflurane group. Compared to sevoflurane, desflurane is thought to cause a higher prevalence of sore throat due to its greater irritation and effect on the inflammatory process. For this reason, we preferred sevoflurane in the inhaler group in our study.

Chen et al. reported that PONV was observed less in the propofol group than in the sevoflurane group in their study in which they compared the results of anesthesia with sevoflurane and propofol using auditory evoked potential in patients who have undergone breast surgery (15). Additionally, several other studies have reported a low incidence of PONV with the use of propofol during the procedure performed (1,8,24,29). However, it is not clear whether propofol is effective on PONV when used only as an induction agent. Therefore, plasma concentrations of propofol within a therapeutic range are thought to be protective against PONV. In the meta-analysis conducted by Schaefer et al., it was emphasized that the risk of experiencing PONV in the late postoperative phase was significantly higher in patients using TIVA than those using inhaled agents (29). Mei et al. also highlighted that the incidence of PONV was higher in the early and late postoperative periods in the sevoflurane group compared to the TIVA group (30). In their study in which operative, anesthetic, and patient-specific risk factors were examined in terms of PONV development, Apfel et al. emphasized that volatile anesthetics were the strongest risk factor (31). In the study, which divided the first 24 h postoperatively into two periods as early (0–2 hours) and late (2–24 hours), they have shown that this result is especially pronounced in the early postoperative period. They stated that it would be more appropriate to avoid inhalational anesthesia instead of applying an antiemetic in patients with a high risk for PONV. In a meta-analysis involving 20,991 adult patients comparing TIVA and inhalation anesthesia for PONV, Schraag et al. reported a lower incidence of PONV with TIVA anesthesia (24). However, Kumar et al. informed that propofol did not decrease nausea and vomiting after discharge in outpatient surgeries in their systematic meta-analysis in which they compared TIVA with inhalation anesthetics (32). They explained this by the fact that propofol has a short half-life, and its pharmacokinetic profile and therapeutic antiemetic plasma levels are unlikely to persist for hours or days after administration. Cattano et al. investigated the postoperative effects of TIVA and inhala-

tion anesthesia and found PONV was equal in both groups at all hours, which is consistent with our study results (33). It is hypothesized that this result may be attributed to the use of propofol for induction in both groups in our study, as well as the administration of antiemetics to all patients before extubation. This suggests that using propofol solely as an induction agent can contribute to its antiemetic properties in the postoperative period.

In our study, when both groups were evaluated in terms of extubation times, it was found that the extubation times of the Group T were longer. Talih et al. compared TIVA with propofol and sevoflurane inhalation anesthesia in rhinoplasty cases and found a shorter extubation time in the propofol group, which differs from our study results (34). Lai et al., in their study investigating the incidence of prolonged extubation in laparoscopic cholecystectomy cases, reported a shorter time to leave the operating room after extubation in the TIVA group compared to the group receiving desflurane inhalation anesthesia (35). Chen et al. found similar extubation times between TIVA with propofol and sevoflurane inhalation anesthesia groups (15). On the other hand, Schraag et al., in a meta-analysis involving 20,991 adult patients, reported longer extubation times and time to exit from the operating room after extubation in the TIVA group compared to inhalation anesthesia (24). Stevanovic et al., who compared TIVA and inhalation anesthesia in laparoscopic cholecystectomies, also found longer extubation times in the TIVA group, which aligns with our study results (36). These differences in outcomes could be attributed to variations in patient populations included in the studies, maintenance doses of the drugs used, and intraoperative discontinuation times of the drugs.

This study has several limitations. First, it was conducted at a single center and the sample size was relatively small. Second, the depth of anesthesia was not monitored by BIS. Monitoring the depth of anesthesia can be valuable in evaluating the effects of different anesthetic techniques and their impact on outcomes. Multicenter studies with a larger number of patients should be conducted on the subject.

## CONCLUSION

In conclusion, this study comparing TIVA with propofol and inhalation anesthesia using sevoflurane in elective septorhinoplasty cases showed that there was no significant difference in the incidence of PONV between the two groups. However, the group receiving TIVA had a lower incidence of postoperative sore throat and required less postoperative analgesic use. Understanding the factors influencing PONV and sore throat can help in implementing necessary precautions to enhance patient comfort and satisfaction. Based on these findings, it is suggested that the use of TIVA with propofol for both induction and maintenance of anesthesia in elective septorhinoplasty cases may be preferable to inhalation anesthesia with sevoflurane, particularly for reducing the risk of sore throat.


## AUTHOR CONTRIBUTIONS

**Conception or design of the work:** MEE, EG, CKK
**Data collection:** MEE, AD, RG
**Data analysis and interpretation:** MEE, RS, OU, CKK
**Drafting the article:** MEE, OA, RS, RG
**Critical revision of the article:** MEE, OU, EG, CKK
The author (MEE, AD, OU, RS, RG, OU, EG, CKK) reviewed the results and approved the final version of the manuscript.


## REFERENCES


1. Simsek HO, Kocaturk Ö, Demetoglu U, Gursoytrak B. Propofol based total intravenous anesthesia versus sevoflurane based inhalation anesthesia: The postoperative characteristics in oral and maxillofacial surgery. J Craniomaxillofac Surg 2020; 48(9):880-4.
2. Çelik EC, Kara D, Koc E, Yayik AM. The comparison of single-dose preemptive intravenous ibuprofen and paracetamol on postoperative pain scores and opioid consumption after open septorhinoplasty: A randomized controlled study. Eur Arch Otorhinolaryngol 2018; 275(9):2259-63.
3. Zhao Y, Qin F, Liu Y, Dai Y, Cen X. The safety of propofol versus sevoflurane for general anesthesia in children: A meta-analysis of randomized controlled trials. Front Surg 2022; 22(9):924647.
4. Wang N, Zhang J, Zhao R et al. Effects of Sevoflurane versus propofol on endogenous nitric oxide metabolism during laparoscopic surgery. J Healthc Eng 2021;2021:6691943.
5. Ji FH, Wang D, Zhang J, Liu HY, Peng K. Effects of propofol anesthesia versus sevoflurane anesthesia on postoperative pain after radical gastrectomy: A randomized controlled trial. J Pain Res 2018;25(11):1247-54.
6. Razavi M, Taghavi Gilani M, Bameshki AR, Behdani R, Khadivi E, Bakhshaee M. Pharyngeal packing during rhinoplasty: Advantages and disadvantages. Iran J Otorhinolaryngol 2015; 27(83):423-8.
7. Park JH, Lee YC, Lee J, Kim S, Kim HC. Influence of intraoperative sevoflurane or desflurane on postoperative sore throat: A prospective randomized study. J Anesth 2019; 33(2):209-15.
8. Jin Z, Gan TJ, Bergese SD. Prevention and treatment of postoperative nausea and vomiting (PONV): A review of current recommendations and emerging therapies. Ther Clin Risk Manag 2020;31(16):1305-17.
9. El-Boghdadly K, Bailey CR, Wiles MD. Postoperative sore throat: A systematic review. Anaesthesia 2016;71(6):706-17.

10. Wang G, Qi Y, Wu L, Jiang G. Comparative Efficacy of 6 Topical Pharmacological Agents for Preventive Interventions of Postoperative Sore Throat After Tracheal Intubation: A Systematic Review and Network Meta-analysis. Anesth Analg 2021;133(1):58-67.
11. Benjamin B. Laryngeal trauma from intubation: Endoscopic evaluation and classification. In: Cummings CW, Fredrickson LM, Harker LA, et al. (eds) Otolarngology Head and Neck Surgery. 2nd edn. St. Louis, Mosby-Year Book 1998;1875-96.
12. Levin PD, Chrysostomos C, Ibarra CA, et al. Causes of sore throat after intubation: A prospective observational study of multiple anesthesia variables. Minerva Anestesiol 2017; 83(6):582-9.
13. Butterworth JF, Mackey DC, Wasnick JD. Adjuncts to Anaesthesia. Morgan & Mikhail's Clinical Anesthesiology, Seventh edition. McGraw Hill LLC United States 2022;17:279-82.
14. Gan TJ, Belani KG, Bergese S, et al. Fourth consensus guidelines for the management of postoperative nausea and vomiting. Anesth Analg 2020;131(2):411-48.
15. Chen HP, Hsu YH, Hua KC, Lin CC, Lo YF, Yu HP. Comparison of sevoflurane versus propofol under auditory evoked potential monitoring in female patients undergoing breast surgery. Biomed J 2013;36(3):125-31.
16. Kramer KJ, Brady JW. Anesthetic agents commonly used by oral and maxillofacial surgeons. Oral Maxillofac Surg Clin North Am 2018;30(2):155-64.
17. Borgeat A, Wilder-Smith OH, Saiah M, Rifat K. Subhypnotic doses of propofol possess direct antiemetic properties. Anesth Analg 1992;74(4):539-41.
18. Gan TJ, El-Molem H, Ray J, Glass PS. Patient-controlled antiemesis: A randomized, double-blind comparison of two doses of propofol versus placebo. Anesthesiology 1999; 90(6):1564-70.
19. Juhász M, Molnár L, Fülesdi B, Végh T, Páll D, Molnár C. Effect of sevoflurane on systemic and cerebral circulation, cerebral autoregulation and $CO_2$ reactivity. BMC Anesthesiol 2019; 19(1):109.
20. Mencke T, Zitzmann A, Machmueller S, et al. Anesthesia with propofol versus sevoflurane: Does the longer neuromuscular block under sevoflurane anesthesia reduce laryngeal injuries? Anesthesiol Res Pract 2013;2013:723168.
21. Maruyama K, Nakagawa H, Imanishi H, Kitamura A, Hayashida M. Comparison of postoperative pharyngeal morbidity using the Macintosh laryngoscope or AirWay Scope after mastectomy. J Anesth 2011;25(5):773-6.
22. Hsu HT, Chou SH, Wu PJ, et al. Comparison of the GlideScope® videolaryngoscope and the Macintosh laryngoscope for double-lumen tube intubation. Anaesthesia 2012;67(4):411-5.
23. Jones PM, Armstrong KP, Armstrong PM, et al. A comparison of glidescope videolaryngoscopy to direct laryngoscopy for nasotracheal intubation. Anesth Analg 2008;107(1):144-8.
24. Schraag S, Pradelli L, Alsaleh AJO, et al. Propofol vs. inhalational agents to maintain general anesthesia in ambulatory and in-patient surgery: A systematic review and meta-analysis. BMC Anesthesiol 2018;18(1):162.
25. Maruyama K, Sakai H, Miyazawa H, et al. Sore throat and hoarseness after total intravenous anesthesia. Br J Anaesth 2004;92(4):541-3.
26. Samir A, Gandreti N, Madhere M, Khan A, Brown M, Loomba V. Anti-inflammatory effects of propofol during cardiopulmonary bypass: a pilot study. Ann Card Anaesth 2015;18(4):495-501.
27. Mikawa K, Akamatsu H, Nishina K, et al. Propofol inhibits human neutrophil functions. Anesth Analg 1998;87(3):695-700.
28. Vasileiou I, Xanthos T, Koudouna E, et al. Propofol: A review of its non-anaesthetic effects. Eur J Pharmacol 2009;605(1-3):1-8.
29. Schaefer MS, Kranke P, Weibel S, Kreysing R, Kienbaum P. Total intravenous anaesthesia versus single-drug pharmacological antiemetic prophylaxis in adults: A systematic review and meta-analysis. Eur J Anaesthesiol 2016;33(10):750-60.
30. Mei W, Li M, Yu Y, et al. Tropisetron alleviate early post-operative pain after gynecological laparoscopy in sevoflurane based general anaesthesia: A randomized, parallel-group, factorial study. Eur J Pain 2014;18(2):238-48.
31. Apfel CC, Kranke P, Katz MH, et al. Volatile anaesthetics may be the main cause of early but not delayed postoperative vomiting: A randomized controlled trial of factorial design. Br J Anaesth 2002;88(5):659-68.
32. Kumar G, Stendall C, Mistry R, Gurusamy K, Walker D. A comparison of total intravenous anaesthesia using propofol with sevoflurane or desflurane in ambulatory surgery: Systematic review and meta-analysis. Anaesthesia 2014; 69(10):1138-50.
33. Cattano D, Gomez-Rivera F, Seitan C, et al. Post-operative effects: Comparison of total intravenous and inhalational anesthesia. J Anesth Clin Res 2012;4:287.
34. Talih G, Yüksek A, Şahin E. Evaluation of emergence agitation after general anaesthesia in rhinoplasty patients: Inhalation anaesthesia versus total intravenous anaesthesia. Am J Otolaryngol 2020;41(3):102387.
35. Lai HC, Hung NK, Lin BF, Chen JL, Huang YH, Wu ZF. Lower incidence of prolonged extubation in propofol-based total intravenous anesthesia compared with desflurane anesthesia in laparoscopic cholecystectomy: A retrospective study. J Med Sci 2019;39(3):121-6.
36. Stevanovic PD, Petrova G, Miljkovic B, et al. Low fresh gas flow balanced anesthesia versus target controlled intravenous infusion anesthesia in laparoscopic cholecystectomy: A cost-minimization analysis. Clin Ther 2018;30(9):1714-25.