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ORIGINAL RESEARCH

Remifentanil versus dexmedetomidine in awake fiberoptic bronchoscopy guided laryngeal surgeries

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Abstract

Background: Awake fiberoptic bronchoscopy (AFB) is an essential technique for securing the airway in patients with complex anatomical challenges, such as laryngeal masses, where conventional intubation may be difficult. This study compares the efficacy of remifentanil and dexmedetomidine for sedation during AFB in patients undergoing laryngeal surgery. **Methods**: This retrospective cohort study analyzed the data of 76 patients who underwent AFB for tracheal intubation between January 2021 and April 2024. The patients were divided into two sedation groups: Remifentanil (n = 38) and Dexmedetomidine (n = 38). The primary outcomes included intubation time, the number of intubation attempts, patient comfort scores, and postoperative cough scores. Sedation was titrated to achieve a Ramsay sedation score of 3–4, and to ensure comparability, baseline characteristics such as demographic data, American Society of Anesthesiologists (ASA) classifications and Mallampati scores were compared. **Results**: The baseline characteristics were similar between the two groups. However, dexmedetomidine was associated with significantly shorter intubation times (52.39 $\pm$ 16.94 *vs.* 70.50 $\pm$ 20.42 seconds, $p < 0.01$), fewer intubation attempts (1.58 $\pm$ 0.56 *vs.* 2.08 $\pm$ 0.62, $p < 0.01$) and better patient comfort scores (1.82 $\pm$ 0.56 *vs.* 2.13 $\pm$ 0.62, $p = 0.02$). Additionally, postoperative cough scores were lower in the dexmedetomidine group (2.00 $\pm$ 0.61 *vs.* 2.32 $\pm$ 0.57, $p = 0.02$), indicating reduced airway irritation after the procedure. **Conclusions**: Dexmedetomidine was associated with superior sedation compared to remifentanil for AFB in patients undergoing laryngeal surgery due to improved patient comfort, shortened intubation time and reduced number of intubation attempts. The lower postoperative cough scores further suggest a potential benefit in minimizing airway irritation. Given its minimal respiratory depressive effects and enhanced procedural efficiency, dexmedetomidine could be the preferred sedative agent for AFB in this patient population.

Keywords

Awake fiberoptic bronchoscopy; Sedation; Remifentanil; Dexmedetomidine; Laryngeal surgery

1. Introduction

Awake fiberoptic bronchoscopy (AFB) is an important procedure for securing the airway in patients with complex anatomical challenges, particularly those with laryngeal masses requiring intubation. AFB is frequently utilized in otolaryngology, particularly for managing difficult airways, where tumors are located at the vocal cords or the base of the tongue [1, 2]. The success of this procedure depends largely on the choice of sedation, which is crucial for optimizing patient comfort, reducing intubation time and enhancing procedural efficiency.

The primary objective of sedation during AFB is to ensure patient cooperation and comfort while preserving airway reflexes and spontaneous breathing. In this regard, various pharmacological agents have been used, among which remifentanil and dexmedetomidine are among the most commonly used. remifentanil, a potent and short-acting opioid, offers rapid onset and precise titration, making it advantageous in situations where sedation depth must be closely controlled [3, 4]. In contrast, dexmedetomidine, an alpha-2 adrenergic agonist, provides sedation with minimal respiratory depression, which is particularly beneficial for maintaining airway patency and facilitating patient cooperation during the procedure [5].

AFB is widely regarded as the preferred technique for managing difficult airways, particularly in patients with laryngeal tumors [6]. Although alternative awake intubation methods, such as video laryngoscopy (VL), may be considered in select cases, their utility remains dependent on specific clinical

circumstances [7]. VL offers enhanced glottic visualization and has the potential to reduce procedural time; however, its effectiveness may be limited in cases where orotracheal access is obstructed by a mass. Given its ability to facilitate precise airway navigation, AFB remains the gold standard, particularly in situations where direct visualization and careful maneuvering are essential. The selection of an intubation technique is influenced by multiple factors, including patient-specific anatomical considerations, clinician expertise and institutional protocols.

Despite the widespread use of remifentanil and dexmedetomidine in AFB, limited comparative data exist regarding their effectiveness in the specific context of laryngeal surgeries [8]. To address this gap, the present study aims to retrospectively evaluate these two sedatives in terms of key clinical outcomes, including intubation time, patient comfort scores, the number of intubation attempts and postoperative cough scores to determine the optimal sedation regimen with superior balance of efficacy and safety for patients undergoing AFB.

Additionally, this study examines the influence of patient-specific factors, such as the Mallampati score and American Society of Anesthesiologists (ASA) classification, on AFB outcomes. The Mallampati score is a widely recognized predictor of intubation difficulty, and the ASA classification provides a standardized assessment of preoperative physical status. Thus, evaluating the impact of these factors may also help refine sedation strategies and improve patient care by tailoring approaches based on individual risk profiles.

Taken together, this present study provides a comparative analysis of remifentanil and dexmedetomidine for sedation during AFB in laryngeal surgery, aiming to generate evidence that can guide clinical decision-making and enhance patient outcomes in otolaryngology.

2. Methods

2.1 Study design

This study used a retrospective cohort design and was conducted at a tertiary hospital. All procedures were performed in accordance with the ethical principles outlined in the Declaration of Helsinki.

2.2 Study population

The study comprised 76 adult patients aged 18 years and older who underwent surgery for laryngeal masses and were intubated using AFB between 01 January 2021 and 30 April 2024.

2.3 Inclusion and exclusion criteria

Patients were included in the study if they had undergone a total laryngectomy, which necessitated a tracheostomy, were aged 18 years or older, and were scheduled for elective surgery. In contrast, cases with perioperative blood loss requiring postoperative vasopressor support, postoperative invasive mechanical ventilation, postoperative sedation or emergency surgery were excluded.

2.4 Anesthesia and sedation protocol

All patients were given a standardized anesthesia regimen to ensure optimal sedation and airway management. Upon arrival in the operating theater, they received an intravenous bolus of midazolam at a dose of 0.01–0.03 mg/kg to induce mild sedation, along with 0.3 mg of atropine to reduce airway secretions. To achieve adequate topical anesthesia, a 2% lidocaine spray was applied to the hypopharynx, followed by patient gargling with 5 mL of 1% lidocaine. Routine monitoring was initiated, and oxygen was administered via a nasal cannula at a flow rate of 4 L/min. Before the administration of the primary sedative agent, all patients received an intravenous dose of fentanyl at 1 mcg/kg to enhance analgesia and facilitate sedation while preserving spontaneous breathing.

Following fentanyl administration, patients were sedated with either dexmedetomidine or remifentanil according to the assigned group. In the dexmedetomidine group, sedation was initiated with a loading dose of 1 mcg/kg infused over 10 minutes, followed by a continuous maintenance infusion at 0.25 mcg/kg/h. In the remifentanil group, an infusion was started at 0.1 mcg/kg/min and adjusted in increments of 0.025 mcg/kg/min until the target sedation level, defined as a Ramsay sedation score of 3–4, was achieved. The infusion rate of remifentanil did not exceed a maximum of 0.5 mcg/kg/min. The procedure commenced only after confirming that the patient had reached the appropriate level of sedation.

2.5 Surgical procedure

All patients included in this study underwent elective laryngectomy for the treatment of laryngeal masses. The procedure involved the surgical removal of the larynx to manage malignant or extensive benign tumors that compromised airway patency. Given the high risk of airway obstruction in this patient population, AFB was performed preoperatively to establish a secure airway before the induction of general anesthesia.

2.6 Sedation group

The patients were categorized into two groups based on the sedation agent used, the Remifentanil Group or the Dexmedetomidine Group.

2.7 Intubation procedure

All patients underwent oral intubation due to the presence of tumors located at the vocal cords or the base of the tongue. A mouthpiece was used during the intubation process to facilitate smooth fiberoptic insertion and minimize patient discomfort. For consistency, all intubations were performed by the same anesthesiologist, who had a minimum of seven years of experience in anesthesiology.

2.8 Data collection

Patient data were extracted from medical records and analyzed based on the following parameters:

- Comfort Score: Patient tolerance during intubation was assessed using the five-point fiberoptic intubation comfort score, where 1 indicated no reaction, 2 indicated slight grimac-

ing, 3 indicated heavy grimacing, 4 indicated verbal objection, and 5 indicated defensive movement of the head and hands.

- Intubation Time: The time required for intubation was recorded, measured from the initial introduction of the bronchoscope to the successful passage of the endotracheal tube through the vocal cords.
- Number of Attempts: The number of intubation attempts was documented, reflecting the count of attempts required to pass the endotracheal tube through the vocal cords.
- Cough Score: The severity of coughing during intubation was assessed using a five-point scale, where 1 indicated no cough, 2 indicated minimal coughing and gagging occurring fewer than three times, 3 indicated mild coughing and gagging lasting more than three times but less than one minute, 4 indicated persistent coughing and gagging, and 5 indicated the need to stop the procedure due to excessive coughing.

2.9 Statistical analysis

A power analysis was conducted based on data from previous studies that evaluated the efficacy of dexmedetomidine and remifentanil in AFB [8, 9]. Considering the reported first-attempt success rates and aiming for a statistical power of 0.8 with a significance level of 0.05, the minimum required sample size was determined to be 64 patients. To account for potential data variability, the target sample size was set at 76, and all 76 patients were successfully enrolled.

All statistical analyses were performed using SPSS (Version 20.0, IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize demographic and clinical data, with continuous variables presented as mean ± standard deviation (SD) and categorical variables expressed as frequencies and percentages. The normality of continuous variables was assessed using the Shapiro-Wilk test. For normally distributed continuous variables, independent samples *t*-tests were used for between-group comparisons, while categorical variables were analyzed using Chi-square tests. Statistical significance was set at $p < 0.05$. Comparative analyses between the two sedation groups included demographic parameters such as gender, ASA classification, Mallampati score and age, as well as primary clinical outcomes, including the Ramsay sedation score, comfort score, intubation time, number of intubation attempts and cough score. Additionally, subgroup analyses were conducted to evaluate the influence of the Mallampati score on these clinical outcomes, with statistical significance determined using a two-tailed significance level of $p < 0.05$.

3. Results

A total of 76 patients were included in the study and were evenly distributed between the two sedation groups, with 38 patients receiving remifentanil and 38 receiving dexmedetomidine. The gender distribution was comparable between the groups, with 27 males and 11 females in the Remifentanil group and 25 males and 13 females in the Dexmedetomidine group ($p = 0.62$). Similarly, ASA classification did not differ significantly between groups, with ASA II/III distributions of 9/29 in the Remifentanil group and 10/28 in the Dexmedetomidine group ($p = 0.79$). The Mallampati classification showed a trend toward a difference between the groups, with 13 patients classified as Mallampati II and 25 as Mallampati III in the Remifentanil group, compared to 21 classified as Mallampati II and 17 as Mallampati III in the Dexmedetomidine group, though this did not reach statistical significance ($p = 0.08$). The mean age of patients was 54.87 ± 13.05 years in the Remifentanil group and 57.89 ± 14.92 years in the Dexmedetomidine group, with no significant difference between groups ($p = 0.35$). The demographic characteristics of the study population are summarized in Table 1.

The comparative clinical outcomes between the two groups are summarized in Table 2. The Ramsay sedation score at the start of the procedure was comparable between the two groups, with a mean of 3.34 ± 0.48 in the Remifentanil group and 3.42 ± 0.50 in the Dexmedetomidine group ($p = 0.48$). However, the comfort score during the procedure was significantly lower in the Dexmedetomidine group (1.82 ± 0.56) compared to the Remifentanil group (2.13 ± 0.62, $p = 0.02$), indicating better patient tolerance with dexmedetomidine.

The intubation time was significantly shorter in the Dexmedetomidine group, with a mean duration of 52.39 ± 16.94 seconds, compared to 70.50 ± 20.42 seconds in the Remifentanil group ($p < 0.001$). Similarly, the number of intubation attempts was lower in the Dexmedetomidine group (1.58 ± 0.56) compared to the Remifentanil group (2.08 ± 0.62, $p = 0.01$), suggesting greater ease of intubation with dexmedetomidine.

No cases of arrhythmia or severe desaturation were observed during the procedure. The lowest recorded Oxygen Saturation (SpO_2) value was 88%, which did not necessitate intervention. The cough score was significantly lower in the Dexmedetomidine group (2.00 ± 0.61) than in the Remifentanil group (2.32 ± 0.57, $p = 0.02$), indicating a reduced incidence of procedural coughing with dexmedetomidine.

The cough score did not differ significantly between patients with Mallampati score 2 (2.21 ± 0.54) and those with Mallampati score 3 (2.12 ± 0.68, $p = 0.56$), suggesting that airway anatomy classification did not substantially impact the severity of procedural coughing. Similarly, the number of intubation attempts was slightly higher in patients with Mallampati score 3 (1.95 ± 0.77) compared to those with a Mallampati score 2 (1.65 ± 0.73), but this difference did not reach statistical significance ($p = 0.08$).

Patient comfort during the procedure remained comparable between the two groups, with a mean comfort score of 1.97 ± 0.67 in the Mallampati 2 group and 1.98 ± 0.57 in the Mallampati 3 group ($p = 0.97$). However, intubation time was significantly longer in patients with Mallampati score 3, with a mean duration of 67.00 ± 23.43 seconds compared to 55.53 ± 14.75 seconds in those with Mallampati score 2 ($p = 0.01$), indicating a greater challenge in securing the airway in patients with higher Mallampati scores. The comparative clinical outcomes based on the Mallampati classification are presented in Table 3.

4. Discussion

This study showed that patients with lower Mallampati scores (Mallampati 2) had significantly shorter intubation times com-

TABLE 1. Demographic characteristics of the study population.

Variables	Remifentanil (n = 38)	Dexmedetomidine (n = 38)	*p*
Gender (M/F)	27/11	25/13	0.62*
ASA (II/III)	9/29	10/28	0.79*
Mallampati (II/III)	13/25	21/17	0.08*
Age (yr) (mean ± SD)	54.87 ± 13.05	57.89 ± 14.92	0.35**

p-values calculated using Chi-square test (*) or Independent sample t-test (**).
M/F: Male/Female; ASA: American Society of Anesthesiologists; SD: standard deviation.

TABLE 2. Comparison of clinical outcomes between remifentanil and dexmedetomidine.

Variables	Remifentanil (Mean ± SD)	Dexmedetomidine (Mean ± SD)	*p**
Ramsey score (at the start)	3.34 ± 0.48	3.42 ± 0.50	0.48
Comfort score (during the procedure)	2.13 ± 0.62	1.82 ± 0.56	0.02
Intubation time (seconds)	70.50 ± 20.42	52.39 ± 16.94	0.008
Number of attempts	2.08 ± 0.62	1.58 ± 0.56	0.004
Cough score	2.32 ± 0.57	2.00 ± 0.61	0.02

**p-values calculated using independent samples t-test.*
SD: standard deviation.

TABLE 3. Comparison of clinical outcomes based on mallampati score.

Variables	Mallampati 2	Mallampati 3	*p**
Cough Score	2.21 ± 0.54	2.12 ± 0.68	0.56
Number of Attempts	1.65 ± 0.73	1.95 ± 0.77	0.08
Comfort Score (during the procedure)	1.97 ± 0.67	1.98 ± 0.57	0.97
Intubation Time (seconds)	55.53 ± 14.75	67.00 ± 23.43	0.01

**p-values calculated using independent samples t-test.*

pared to those with higher scores (Mallampati 3), indicating that airway classification plays a crucial role in procedural efficiency. However, other parameters, including comfort score, cough score and the number of intubation attempts, did not differ significantly between the two groups, suggesting that intubation time is the most sensitive indicator of airway difficulty in this setting.

In this study, patients sedated with dexmedetomidine were found to have significantly shorter intubation times and required fewer intubation attempts compared to those receiving remifentanil, consistent with those reported by Sancheti *et al.* [10], who demonstrated that dexmedetomidine provides effective sedation while maintaining spontaneous breathing, preserving airway patency and improving patient cooperation during AFB. Similarly, Zhou *et al.* [5] highlighted the advantages of dexmedetomidine in procedures requiring precise sedation control without compromising respiratory function. These studies collectively confirm the advantages of dexmedetomidine in enhancing procedural efficiency and safety.

Although some studies, such as those by Hu *et al.* [11], suggested comparable efficacy between remifentanil and dexmedetomidine for certain parameters, the present study found significant differences in intubation times and the number of attempts, favoring dexmedetomidine. We believe that these discrepancies may be attributed to variations in patient populations, procedural protocols and dosing regimens across studies. In the study conducted by Hu *et al.* [11], a broader demographic was included, and the research was performed in different procedural settings, which may have influenced the outcomes. Furthermore, variations in dosing strategies for dexmedetomidine and remifentanil across clinical protocols could have affected sedation depth and overall procedural efficiency, potentially contributing to the differences observed between studies.

Other studies have also highlighted the unique pharmacokinetic properties of dexmedetomidine that make it particularly suitable for AFB. For instance, Kan *et al.* [12] described its rapid onset and short duration of action, which enable precise titration and sedation control, making it well-suited for procedures requiring patient cooperation while minimizing respiratory depression. Similarly, a review by Fraser and Riker emphasized that dexmedetomidine's sedative effects, combined with its minimal impact on respiratory function, offer a distinct advantage in the management of complex airway procedures [3].

In this study, conventional oxygen therapy via nasal cannula was selected over high-flow nasal cannula (HFNC) based on institutional protocols and its practicality in AFB. Although

HFNC has been demonstrated to provide superior oxygenation and reduce the risk of peripheral desaturation [13], its use in patients with laryngeal masses presents challenges, including the potential for airway obstruction and difficulty in maintaining upper airway patency. Furthermore, HFNC may not be well tolerated by awake patients undergoing AFB due to the discomfort associated with high gas flow rates. Given these considerations, conventional oxygen therapy was considered sufficient to maintain adequate oxygenation, particularly in regard to the relatively short duration of the intubation process in this study.

Moreover, several clinical trials and meta-analyses have demonstrated the superiority of dexmedetomidine over remifentanil in terms of patient satisfaction and procedural outcomes [4, 11, 14–16]. A Cochrane review further emphasized that dexmedetomidine not only reduces patient discomfort during AFB but also lowers the incidence of airway obstruction and respiratory complications compared to remifentanil, highlighting its advantages in maintaining airway patency and procedural tolerance [10]. These findings collectively support the use of dexmedetomidine as a preferred sedative agent for AFB, reinforcing its potential to improve clinical outcomes and enhance patient safety in the management of complex airways.

A meta-analysis conducted by Tang *et al.* [17], which included eight studies with a total of 412 patients, concluded that while both remifentanil and dexmedetomidine are effective and well-tolerated for AFB, dexmedetomidine may offer additional advantages by reducing the incidence of hypoxemia and memory recall of the procedure.

Acharya *et al.* [18] demonstrated that a low-dose Dexmedetomidine-fentanyl combination provides intubation conditions comparable to those achieved with standard-dose dexmedetomidine while significantly reducing the incidence of bradycardia and hypotension during AFB. These results align with our findings and emphasize the importance of sedation strategies that not only optimize intubation conditions but also ensure hemodynamic stability, particularly in patients with a high risk of cardiovascular compromise.

Similarly, El-Boghdadly *et al.* [8] conducted a systematic review and network meta-analysis comparing 33 different sedation regimens for awake tracheal intubation and found no definitive superiority of any specific regimen in terms of success rate or intubation time. Their findings highlight that factors such as optimized oxygenation, airway anesthesia, and procedural techniques may be more critical than the choice of sedative alone, which aligns with our study's approach and underscores the importance of both sedation and procedural optimization to enhance patient comfort and intubation success. Additionally, their results reinforce the role of dexmedetomidine in minimizing oxygen desaturation risk, further supporting our findings regarding its hemodynamic stability and efficacy in AFB.

Sachan *et al.* [19] compared dexmedetomidine with a fentanyl-midazolam combination for awake fiberoptic intubation (AFOI) in patients with difficult airways and found that dexmedetomidine provided superior intubation conditions, enhanced patient comfort and greater endoscopist satisfaction. Their findings confirmed the advantages of dexmedetomidine in reducing hemodynamic fluctuations and minimizing respiratory depression, making it a safer option for AFOI. Overall, these results are consistent with our study, further supporting the role of dexmedetomidine in optimizing patient tolerance and procedural success during awake intubation.

In summary, the consistency of our findings with existing literature reinforces the reliability of dexmedetomidine as a sedative for AFB. Its ability to provide effective sedation while maintaining respiratory function and facilitating patient cooperation makes it a more favorable option than remifentanil in many clinical settings. Although some studies have reported differing results, these variations may be attributed to differences in study design, patient demographics and dosing protocols. Future research should focus on establishing standardized sedation protocols to further validate the efficacy and safety of dexmedetomidine in AFB.

5. Clinical implications

Dexmedetomidine provides effective sedation while minimizing respiratory depression, making it well-suited for AFB, especially in patients with compromised airways. Its association with shorter intubation times and fewer intubation attempts improves procedural efficiency and enhances patient safety. Additionally, lower postoperative cough scores indicate greater patient tolerance and a faster recovery, leading to higher patient satisfaction and reduced postoperative care requirements.

6. Limitations

The retrospective design and relatively small sample size of this study limit the generalizability of the findings. Larger, multicenter randomized controlled trials are necessary to validate these results and provide more robust evidence. Furthermore, this study did not assess long-term outcomes or potential side effects beyond the immediate postoperative period, which could offer a more comprehensive evaluation of the overall impact of the sedatives used for AFB.

7. Conclusions

Despite its limitations, this study provides valuable insights into sedation strategies for AFB, highlights the advantages of dexmedetomidine in specific patient populations, and contributes to evidence-based decision-making, thereby assisting clinicians in selecting the most appropriate sedative for their patients.

In conclusion, dexmedetomidine demonstrated significant advantages over remifentanil for sedation during AFB in patients with laryngeal masses. Its ability to provide effective sedation with minimal respiratory depression, along with shorter intubation times and fewer intubation attempts, supports its role as a safer and more efficient option. Future research could focus on larger patient cohorts and prospective study designs to further validate these findings and assess long-term outcomes.

AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available on reasonable request from the corresponding author.

AUTHOR CONTRIBUTIONS

OS—enrolled most of the patients, collected data and drafted the manuscript. EİT—performed the statistical analysis, proof-read the article and finalized the manuscript. ÖA, EM and HA—participated in patient enrollment, data collection and obtaining ethical committee approval. FGÖ—contributed to manuscript editing and proofreading. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was conducted retrospectively using existing data and informed consent was obtained from all patients prior to their inclusion in the study, ensuring adherence to ethical guidelines and patient autonomy. Ethical approval was obtained from Basaksehir Cam and Sakura City Hospital Ethics Committee (Approval number: KAEK/10.07.2024.77).

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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