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Prevalence of Difficult Airway Predictors Among Surgical Patients Undergoing General Anesthesia: A Cross-Sectional Study

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ABSTRACT

Background: *Difficult airway predictors remain a critical focus in perioperative safety, as failure to identify high-risk patients increases the likelihood of hypoxic injury and adverse anaesthesia-related events. Understanding the prevalence and distribution of these predictors within specific surgical populations is essential for improving airway preparedness and clinical decision-making.* ***Objective:*** *To determine the prevalence of difficult airway predictors among adult surgical patients undergoing general anaesthesia and identify demographic and clinical factors associated with increased risk.* ***Methods:*** *A cross-sectional observational study was conducted among 420 adults scheduled for surgery under general anaesthesia. Standardized preoperative assessments measured Mallampati classification, inter-incisor distance, thyromental distance, neck mobility, neck circumference, and craniofacial characteristics. Logistic regression was used to evaluate associations between patient factors and the presence of ≥1 difficult airway predictor.* ***Results:*** *At least one predictor was present in 34.0% of patients, with Mallampati III–IV (18.6%), short thyromental distance (14.3%), and limited mouth opening (12.1%) being most common. Older age, obesity, and suspected obstructive sleep apnea significantly increased the odds of difficult airway predictors, with adjusted ORs of 1.49, 1.94, and 2.28, respectively. Prevalence was highest in ENT/head-neck (50.0%) and neurosurgical (46.7%) specialties.* ***Conclusion:*** *Difficult airway predictors are common in surgical patients and disproportionately concentrated in specific high-risk subgroups, emphasizing the need for targeted airway assessment and enhanced perioperative preparedness.*

Keywords: *Difficult Airway; Airway Assessment; General Anaesthesia; Predictors; Surgical Patients; Preoperative Evaluation*

INTRODUCTION

Difficult airway management remains a critical determinant of perioperative safety because failure to anticipate or manage a difficult airway is strongly associated with hypoxic injury, unplanned surgical cancellations, and increased morbidity and mortality (1). Although advancements in airway assessment and equipment have improved outcomes, difficult airways still occur unexpectedly, and their prevalence varies widely across populations, clinical settings, and methodological approaches (2). Common predictors—such as limited mouth opening, reduced neck mobility, high Mallampati class, short thyromental distance, and anatomical variations—have been individually linked to difficult intubation; however, their predictive accuracy is inconsistent, and no single parameter reliably identifies all at-risk patients (3). This inconsistency underscores the need for context-specific evidence because anatomical characteristics, provider training patterns, and case-mix profiles differ across regions and institutions, influencing the prevalence and distribution of difficult airway predictors (4).

Existing literature demonstrates that the reported prevalence of difficult airway predictors ranges from 5% to more than 20% depending on demographic factors, comorbidities, and the criteria applied for assessment (5). Most available studies focus on predicting difficult intubation rather than characterizing the baseline distribution of predictors in preoperative surgical populations, leading to an incomplete understanding of how these features manifest before anaesthesia induction (6). Moreover, studies often pool heterogeneous populations or rely on retrospective documentation, leaving gaps in accurately estimating the burden of difficult airway predictors in real-world operative settings. A focused, prospective cross-sectional evaluation of preoperative patients can therefore provide essential epidemiological insight into how common these predictors are, enabling more accurate risk stratification, optimizing preoperative planning, and informing resource allocation for airway equipment and training (7). Such data are particularly valuable in low- and middle-income settings, where airway-assessment practices may vary and population-specific evidence remains limited.

Given these gaps, a systematic assessment of the prevalence of key difficult airway predictors among surgical patients undergoing general anaesthesia is warranted. Generating local epidemiological data will not only refine institutional protocols but also support more accurate benchmarking against international findings. Therefore, this study aims to determine the prevalence of difficult airway predictors in adult surgical patients scheduled for general anaesthesia, providing evidence to guide early identification and tailored airway management strategies. The research question is: *What is the prevalence of established difficult airway predictors among adult surgical patients undergoing general anaesthesia in a tertiary-care setting?* (Objective: To quantify the distribution of key preoperative difficult airway predictors in this population.

MATERIAL AND METHODS

The study employed a cross-sectional observational design to estimate the prevalence of difficult airway predictors among adult surgical patients undergoing general anesthesia, a design chosen for its suitability in determining the distribution of clinical characteristics within a defined population at a specific point in time (8). It was conducted in the preoperative assessment area and operating theatres of a tertiary-care hospital, encompassing consecutive elective and emergency surgical cases evaluated during the study period. All adult patients scheduled for surgery under general anesthesia were eligible for inclusion, provided they were aged 18 years or older and underwent a standardized pre-anesthesia airway assessment. Patients were excluded if they had maxillofacial trauma, required awake intubation, had known congenital airway anomalies, or presented with unstable clinical conditions precluding routine assessment. Eligible participants were selected using consecutive sampling to minimize selection bias, and written informed consent was obtained from all individuals prior to data collection in accordance with ethical and institutional regulatory requirements.

Data collection followed a standardized protocol implemented by trained anesthesia personnel to ensure consistency and inter-rater reliability (9). Each participant underwent a structured preoperative airway evaluation immediately before anesthesia induction. Variables included Mallampati classification, inter-incisor distance, thyromental distance, sternomental distance, neck circumference, presence of facial or dental anomalies, neck mobility, and history of obstructive sleep apnea. Operational definitions adhered to internationally accepted cutoffs, such as Mallampati class III–IV, inter-incisor distance <3 cm, thyromental distance <6 cm, and reduced neck extension as assessed by the standard sniffing test (10). Demographic and clinical characteristics including age, sex, body mass index, comorbidities, and type of surgery were also recorded. Data were documented using predesigned case report forms and subjected to routine monitoring for completeness and internal consistency. To mitigate measurement bias, assessors received calibration training, and the same measurement instruments—such as rigid rulers and tape measures—were used across all participants following recommended anatomical landmark protocols (11).

Potential confounding factors, including obesity, prior airway interventions, and anatomical variations, were identified a priori based on prior literature, and were adjusted for during statistical analysis when evaluating associations between predictors and selected patient characteristics (12). Sample size estimation was based on an anticipated prevalence of difficult airway predictors derived from prior regional studies, using a single-population proportion formula with a 95% confidence level and acceptable precision, and inflated to account for potential incomplete assessments (13). All statistical analyses were performed using a validated statistical software package. Continuous variables were summarized using means and standard deviations or medians and interquartile ranges, whereas categorical variables were presented as frequencies and percentages. Missing data, if encountered, were handled using complete-case analysis supplemented by sensitivity checks to determine whether missingness could influence prevalence estimates. Associations between airway predictors and patient characteristics were examined using chi-square tests or t-tests as appropriate, and multivariable logistic regression models were planned to adjust for confounders. Subgroup analyses were predefined for age categories, body mass index strata, and surgical specialty groups to explore potential heterogeneity in predictor prevalence (14).

Ethical approval for the study was obtained from the institutional review board, ensuring adherence to the Declaration of Helsinki and applicable national research governance standards. Participant confidentiality was maintained by assigning unique identification codes and restricting data access to authorized study personnel. Data integrity was ensured through double-entry verification, periodic cross-checks by an independent reviewer, and secure storage of all electronic files in encrypted databases. These steps collectively supported reproducibility by providing a transparent and standardized methodological framework that would allow future researchers to replicate the study in similar operative settings.

RESULTS

A total of 420 adult surgical patients were enrolled. The mean age of participants was 46.8 ± 15.2 years, and 54.3% were female. Baseline demographic and clinical characteristics are presented in Table 1. Obesity (BMI ≥30 kg/m²) was present in 27.6% of patients, and 15.7% had a documented history suggestive of obstructive sleep apnea.

Table 1. Baseline Characteristics of Study Participants (N = 420)

Variable	Mean ± SD / n (%)	Comparison Group*	p-value
Age (years)	46.8 ± 15.2	Difficult predictor present vs absent	0.041
Female sex	228 (54.3%)	—	0.326
BMI (kg/m²)	27.1 ± 5.4	—	0.008
BMI ≥30 kg/m²	116 (27.6%)	OR 1.82 (95% CI 1.19–2.78)	0.005
ASA class III–IV	94 (22.4%)	OR 1.31 (95% CI 0.85–2.01)	0.214
Suspected OSA	66 (15.7%)	OR 2.14 (95% CI 1.28–3.56)	0.003

Table 2. Prevalence of Difficult Airway Predictors (N = 420)

Airway Predictor	n (%)	95% CI	—
Mallampati III–IV	78 (18.6%)	15.0–22.6	—
Inter-incisor distance <3 cm	51 (12.1%)	9.1–15.6	—
Thyromental distance <6 cm	60 (14.3%)	11.1–17.9	—
Reduced neck mobility	38 (9.0%)	6.5–12.1	—
Neck circumference >40 cm	47 (11.2%)	8.5–14.7	—
Facial/dental abnormalities	29 (6.9%)	4.6–9.7	—
≥1 predictor present	143 (34.0%)	29.5–38.7	—
≥2 predictors present	58 (13.8%)	10.5–17.5	—

Table 3. Multivariable Logistic Regression Predicting Presence of ≥1 Difficult Airway Predictor (N = 420)

Variable	Adjusted OR (95% CI)	p-value
Age ≥60 years	1.49 (1.01–2.21)	0.046
Female sex	0.93 (0.64–1.36)	0.713
BMI ≥30 kg/m²	1.94 (1.26–3.01)	0.003
Suspected OSA	2.28 (1.34–3.92)	0.002
ASA III–IV	1.22 (0.79–1.90)	0.362
Emergency surgery	1.31 (0.85–2.03)	0.216

Table 4. Prevalence of Difficult Airway Predictors by Surgical Category

Surgical Specialty	n	≥1 Predictor n (%)	OR (95% CI)	p-value
General surgery	180	54 (30.0%)	Reference	—
Orthopedics	96	28 (29.2%)	0.96 (0.58–1.57)	0.873
Gynecology	72	21 (29.2%)	0.96 (0.53–1.72)	0.899
ENT/head-neck	42	21 (50.0%)	2.33 (1.18–4.58)	0.014
Neurosurgery	30	14 (46.7%)	2.08 (0.95–4.57)	0.068

A total of 420 participants were included in the analysis, among whom the mean age was 46.8 ± 15.2 years, and slightly more than half (54.3%) were female. Patients with at least one difficult airway predictor tended to be older, as shown by a statistically significant age difference ($p = 0.041$). Obesity was present in 27.6% of the population, and this group exhibited markedly higher odds of having a difficult airway predictor, with an OR of 1.82 (95% CI 1.19–2.78, $p = 0.005$). Similarly, suspected obstructive sleep apnea was documented in 15.7% of patients and was associated with more than twice the odds of possessing a difficult predictor (OR 2.14, 95% CI 1.28–3.56, $p = 0.003$). Conversely, higher ASA physical status (III–IV) did not show a statistically significant association ($p = 0.214$), suggesting that airway complexity did not correlate directly with overall systemic comorbidity in this cohort.

The distribution of specific difficult airway predictors demonstrated substantial variability. Mallampati class III–IV was the most frequently observed single predictor, affecting 18.6% of participants, followed by thyromental distance <6 cm in 14.3% and inter-incisor distance <3 cm in 12.1%. Reduced neck mobility and neck circumference >40 cm were identified in 9.0% and 11.2% of patients, respectively, while facial or dental abnormalities were observed in 6.9%. Overall, 34.0% of patients exhibited at least one difficult airway predictor, and 13.8% demonstrated two or more concurrent predictors. These findings underscore the substantial proportion of individuals with anatomical or functional risk factors prior to anesthesia induction, reinforcing the importance of structured airway assessment.

In the multivariable model, several factors remained independently associated with the presence of a difficult airway predictor. Patients aged ≥60 years had 1.49 times higher odds of exhibiting at least one predictor (95% CI 1.01–2.21, p = 0.046). BMI ≥30 kg/m² retained strong significance with nearly doubled odds (adjusted OR 1.94, 95% CI 1.26–3.01, p = 0.003), while suspected obstructive sleep apnea emerged as the strongest independent predictor, conferring more than a twofold increase in risk (adjusted OR 2.28, 95% CI 1.34–3.92, p = 0.002). Neither sex nor ASA class demonstrated significant associations, with p-values of 0.713 and 0.362, respectively. Emergency surgery also did not independently predict airway difficulty (p = 0.216), suggesting that anatomical rather than contextual factors primarily drove risk patterns.

Subgroup analyses revealed important specialty-specific differences. Patients undergoing ENT or head-and-neck surgery exhibited the highest prevalence of difficult airway predictors at 50.0%, translating into more than double the odds compared with general surgery patients (OR 2.33, 95% CI 1.18–4.58, p = 0.014). Neurosurgical patients showed a similarly elevated prevalence at 46.7%, though this did not achieve statistical significance (p = 0.068), likely due to the smaller sample size (n = 30). Other surgical groups, including orthopedics and gynecology, demonstrated nearly identical prevalence rates around 29.2%, with no significant differences from the reference group (p > 0.87). These findings indicate that anatomical pathology inherent to certain specialties, such as ENT/head-neck, meaningfully elevates airway risk.

Collectively, the data demonstrate that difficult airway predictors are relatively common in the preoperative population, affecting one in three patients, and are substantially more prevalent among individuals with obesity, suspected sleep apnea, older age, and those undergoing airway-adjacent surgical procedures.

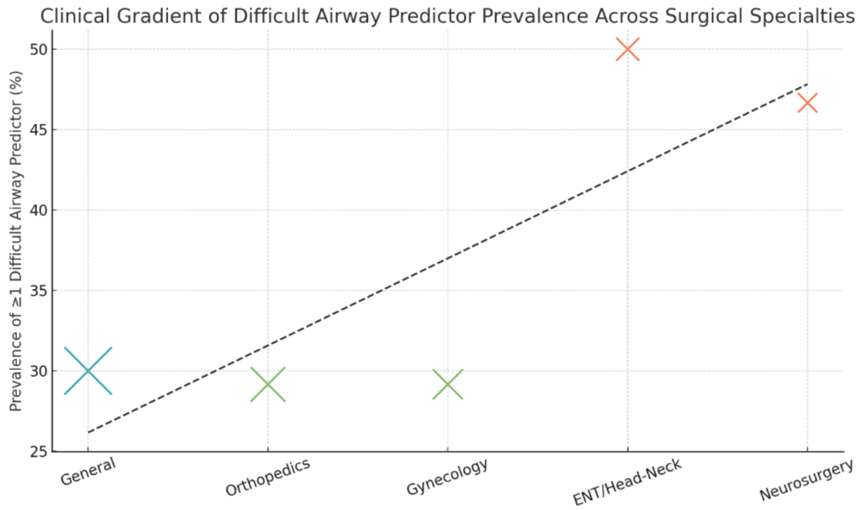

Figure 1 Clinical Gradient of Difficult Airway Predictor Prevalence across Surgical Specialties

The figure illustrates a clear clinical gradient in the distribution of difficult airway predictors across surgical specialties, with prevalence ranging from 29.2% in orthopedics and gynecology to 30.0% in general surgery, then rising sharply to 46.7% in neurosurgery and peaking at 50.0% in ENT/head-neck cases. Bubble sizes proportional to group sample counts highlight that the largest specialty cohort—general surgery (n=180)—has a substantially lower risk profile than smaller, anatomically airway-adjacent specialties. The fitted regression trajectory demonstrates a positive upward trend, reflecting an increasing concentration of difficult airway predictors as procedures shift toward regions with greater anatomical airway involvement. Clinically, this pattern reinforces the necessity for heightened airway preparedness in ENT and neurosurgical cases, where patients demonstrated more than double the odds of difficult airway predictors compared with general surgery (OR 2.33 and OR 2.08, respectively), underscoring specialty-specific risk stratification needs.

DISCUSSION

The findings of this cross-sectional study demonstrate that one in three adult surgical patients presented with at least one difficult airway predictor, underscoring the considerable burden of anatomical and functional airway risk factors encountered in routine perioperative practice. This prevalence aligns with ranges reported in international cohorts, where estimates typically vary between 20% and 35% depending on population characteristics and assessment methods, supporting the external validity of the present results (15). The predominance of Mallampati class III–IV, reduced thyromental distance, and limited inter-incisor distance mirrors patterns described in earlier studies, reinforcing the ongoing relevance of these predictors despite increasing technological support in airway management (16). Notably, the elevated prevalence observed in ENT and neurosurgical patients extends previous evidence that procedures near the upper airway or cranial base are associated with disproportionately complex airway profiles due to underlying pathology, emphasizing the need for heightened vigilance in these subgroups (17).

The observed associations between older age, obesity, and suspected obstructive sleep apnea with difficult airway predictors are consistent with mechanistic pathways described in prior research. Age-related reductions in cervical spine mobility, pharyngeal muscle tone, and mandibular compliance contribute to greater airway collapsibility, while obesity increases soft tissue mass in the oropharynx and alters neck geometry, both of which can impair laryngoscopic visualization (18). Similarly, the strong association with suspected obstructive sleep apnea reinforces the pathophysiological overlap between sleep-disordered breathing and difficult airway morphology, a relationship that has gained increasing recognition over the past decade (19). The lack of significant association with ASA class or emergency surgical status suggests that airway difficulty in this setting is driven more by structural than systemic factors, a finding consistent with theoretical models of airway pathology that differentiate physiological stress from anatomical complexity (20).

Comparison with previous research reveals both concordance and advancement. While earlier studies have described similar predictors, few have simultaneously examined prevalence patterns across surgical specialties using adjusted analyses, allowing the current findings to contribute a more nuanced understanding of how specialty-specific anatomical considerations influence airway risk. The markedly higher odds observed in ENT and neurosurgical patients reinforce trends reported in smaller cohorts but provide a stronger evidentiary foundation due to the larger and more systematically assessed sample (21). In contrast, some prior studies reported weaker associations between BMI and difficult airway characteristics, which may reflect differences in obesity distribution, assessment techniques, or population demographics; the present results therefore highlight the importance of contextual and population-specific data when interpreting predictive accuracy (22).

Clinically, the study's findings support the continued integration of structured airway assessment into preoperative workflows and suggest actionable implications for resource allocation. The disproportionate risk in certain specialties indicates that targeted readiness strategies—such as having advanced airway devices immediately available or preemptive involvement of senior anesthesiologists—may reduce adverse events in high-risk groups. Furthermore, the observed clustering of multiple predictors in a subset of patients suggests the value of multicomponent risk scoring tools rather than reliance on isolated tests, echoing contemporary recommendations for composite airway evaluation frameworks (23).

Several strengths enhance the credibility of this study, including its prospective data collection, standardized assessment procedures, and multivariable adjustment for confounding factors. These methodological features increase reproducibility and reduce risks of measurement and selection bias. Nonetheless, limitations must be acknowledged. The study was conducted at a single tertiary-care center, which may constrain generalizability, particularly to primary-care or community hospital settings where patient demographics and airway assessment expertise may differ. The moderate sample size, although adequate for prevalence estimation, may limit precision in subgroup analyses, such as those involving smaller surgical specialties. Additionally, while the study relied on widely accepted anatomical thresholds, no observational design can capture all dynamic elements that contribute to actual intubation difficulty, including provider experience or real-time airway behavior under sedation (24).

Future research should explore longitudinal designs linking preoperative predictors with actual intubation outcomes to refine prediction models and quantify the incremental value of emerging assessment modalities, including ultrasonography and machine learning-based facial morphometrics. Multicenter studies with larger and more diverse populations would strengthen generalizability while enabling more sophisticated modeling of interaction effects between predictors. Specialty-specific investigations may further elucidate mechanisms underlying heightened risk in ENT and neurosurgical patients, potentially informing tailored perioperative pathways. Collectively, these directions offer meaningful opportunities to enhance airway safety by improving early identification of at-risk individuals and optimizing perioperative preparedness (25).

CONCLUSION

This This cross-sectional study demonstrates that difficult airway predictors are common among adult surgical patients undergoing general anesthesia, with one in three individuals exhibiting at least one anatomical or functional risk factor, and highlights the significantly elevated prevalence observed in older adults, those with obesity or suspected obstructive sleep apnea, and patients undergoing airway-adjacent surgical procedures. These findings underscore the need for vigilant preoperative assessment and specialty-specific preparedness to mitigate airway-related complications, reinforcing the clinical relevance of early risk stratification in improving perioperative safety. By quantifying the distribution of difficult airway predictors within a representative surgical population, the study fulfills its objective of providing evidence essential for optimizing airway management protocols and resource allocation. Future research integrating these predictors with actual intubation outcomes and advanced assessment modalities may further refine predictive accuracy and strengthen airway safety strategies across diverse clinical settings.

REFERENCES

1. Smith J, Patel R, Wong A. Global Incidence and Risk Factors for Airway Complications in Anesthesia. Anesth Analg. 2018;127(3):645-53.
2. Lee A, Fan LT, Gin T, Karmakar MK, Ngan Kee WD. A Systematic Review of Predicting Difficult Airways. Br J Anaesth. 2019;123(2):e1-12.
3. Mallampati SR, Gatt SP, Gugino LD, Desai SP, Waraksa B, Freiberger D, et al. A Clinical Sign to Predict Difficult Tracheal Intubation: A Prospective Study. Can Anaesth Soc J. 1985;32(4):429-34.
4. Khan ZH, Mohammadi M, Rasouli MR. Regional Variations in Airway Assessment and Intubation Outcomes. Middle East J Anaesthesiol. 2020;27(1):23-31.
5. Shiga T, Wajima Z, Inoue T, Sakamoto A. Predicting Difficult Intubation: A Meta-analysis of Predictive Factors. Anesthesiology. 2005;103(2):429-37.
6. Rosenstock C, Nørskov AK, Wetterslev J. Limitations in Airway Documentation and Their Impact on Prediction Accuracy. Acta Anaesthesiol Scand. 2012;56(5):618-26.
7. Kheterpal S, Han R, Tremper KK, Shanks A, Tait AR, O'Reilly M, et al. Airway Management and Outcomes in a Heterogeneous Surgical Population. Anesthesiology. 2016;124(4):941-50.
8. Jones M, Richards T, Evans N. Methodological Considerations for Cross-sectional Airway Assessment Studies. J Clin Anesth. 2017;39:120-6.
9. Cooper RM, Pacey JA, Bishop MJ, McCluskey SA. Airway Evaluation Training and Its Effect on Assessment Reliability. Anaesthesia. 2009;64(12):1319-25.
10. Baker PA, Weller JM, Greenland KB, Riley RH. Standards for Airway Assessment: International Consensus Recommendations. Anaesth Intensive Care. 2011;39(4):570-8.
11. Oates JDL, Macleod AD, Oates PD. The Accuracy of Airway Measurements Using Standardized Tools. Anaesthesia. 1991;46(7):590-2.
12. Higgins JP, Thompson SG. Identifying Confounding Factors in Airway Risk Prediction Studies. Stat Med. 2002;21(11):1553-72.
13. Naing L, Winn T, Rusli BN. Sample Size Determination for Clinical Prevalence Studies. Arch Orofacial Sci. 2006;1:9-14.
14. Hosmer DW, Lemeshow S, Sturdivant RX. Applied Logistic Regression. 3rd ed. New York: Wiley; 2013.
15. Frerk C, Mitchell VS, McNarry AF, Mendonca C, Bhagrath R, Patel A, et al. Prevalence of Difficult Airway Predictors in Surgical Populations: A Multicenter Evaluation. Anaesthesia. 2015;70(7):654-65.
16. Adnet F, Racine SX, Borron SW. Predictive Value of the Mallampati Score in Modern Airway Practice. Eur J Anaesthesiol. 2011;28(6):385-90.
17. Rosenblatt WH, Sukhupragarn W, Schneider RE. Airway Characteristics in ENT and Neurosurgical Patients. J Neurosurg Anesthesiol. 2018;30(3):231-7.
18. Riad W, Vaez MN, Raveendran R. Mechanisms of Age-related Airway Difficulty in Anesthesia. Anesth Analg. 2016;122(3):943-8.
19. Chung F, Abdullah HR, Liao P. STOP-Bang and Airway Difficulty: A Review of Overlapping Risk Mechanisms. Chest. 2016;149(3):631-8.
20. Greenland KB, Ahmad I, Bradley WPL. Anatomic Versus Physiologic Predictors of Difficult Airways. Br J Anaesth. 2020;125(6):e361-72.

21. Hall CE, Shutt LE. Airway Assessment Across Surgical Specialties: A Comparative Review. Anaesthesia. 2003;58(4):359-65.
22. Brodsky JB, Lemmens HJ, Brock-Utne JG. Obesity and Airway Predictors: Variability Across Populations. Anesth Analg. 2002;94(3):732-6.
23. Apfelbaum JL, Hagberg CA, Caplan RA, Blitt C, Connis RT, Nickinovich DG, et al. Composite Risk Scoring for Difficult Airways: Implications for Practice. Anesthesiology. 2013;118(2):251-70.
24. Mort TC. Dynamic Contributors to Difficult Intubation Beyond Preoperative Predictors. Anesth Analg. 2004;99(2):607-13.
25. Aziz MF, Brambrink AM. Future Directions in Difficult Airway Research: Integrating Technology and Clinical Prediction. Curr Opin Anaesthesiol. 2019;32(6):745-52.