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Incidence and predictors of difficult airway in elective surgical patients: A hospital-based observational study.

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Abstract

Background:
Difficult airway remains a major challenge in anesthetic practice and is associated with increased perioperative morbidity when not anticipated. Despite routine preoperative evaluation, unexpected airway difficulty continues to occur in elective surgical patients, highlighting the need to identify reliable predictive parameters.

Objectives:
To determine the proportion of difficult airways among elective surgical patients and to assess the predictive value of commonly used preoperative airway assessment parameters.

Materials and Methods:
This hospital-based observational study included 80 adult patients undergoing elective surgery under general anesthesia with endotracheal intubation. Preoperative airway assessment included Mallampati classification, thyromental distance, inter-incisor distance, cervical spine mobility, and neck circumference. Laryngoscopy was performed using a Macintosh blade. Difficult laryngoscopy was defined as Cormack–Lehane grade III or IV, while difficult intubation was defined by more than two attempts, prolonged intubation time, or need for advanced adjuncts. Data were analyzed using descriptive statistics and multivariate logistic regression.

Results:
The proportion of patients with a difficult airway was 13.8%. Difficult laryngoscopy occurred in 12.5% and difficult intubation in 8.8% of cases. Higher Mallampati grades (III–IV), reduced thyromental distance (<6.5 cm), restricted mouth opening, limited cervical mobility, and increased neck circumference (>40 cm) were significantly associated with a difficult airway. Multivariate analysis identified reduced thyromental distance (Adjusted OR 4.2) and Mallampati Class III–IV (Adjusted OR 3.6) as the strongest independent predictors. Mild desaturation occurred exclusively in the difficult airway group.

Conclusion:
Focused preoperative assessment using Mallampati grading and thyromental distance, supported by complementary airway parameters, can facilitate early identification of high-risk patients and improve perioperative airway safety.

Recommendations:
Standardized airway assessment and readiness with basic airway adjuncts should be ensured for high-risk patients.

Keywords: *Difficult airway; elective surgery; Mallampati grading; thyromental distance; airway predictors; anesthesia safety.*
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Introduction

Securing a dependable airway is a central task in anesthetic practice, as failure to maintain ventilation can rapidly lead to desaturation, airway trauma, cardiovascular instability, and occasionally fatal consequences. Reports from diverse surgical environments show that difficult mask ventilation and difficult intubation continue to occur despite improvements in airway devices and training programs [1,6]. The incidence varies across regions and clinical contexts, reflecting differences in patient characteristics, surgical indications, and methods of airway assessment [1,2].

A structured preoperative evaluation plays a major role in anticipating airway challenges. Bedside tests such as Mallampati grade, thyromental distance, inter-incisor gap, cervical spine mobility, and neck circumference offer useful clues, although none of them consistently predict difficulty when used alone [1,3]. Findings from both elective and emergency care settings highlight the need for multimodal assessment strategies and standardized risk stratification tools to improve diagnostic accuracy [2,5]. Expert consensus also emphasizes integrating anatomical, physiological, and functional parameters rather than relying solely on single measurements [5].

Certain patient groups, including those with undiagnosed obstructive sleep apnoea, demonstrate a higher frequency of difficult laryngoscopy and intubation, underscoring the value of thorough preoperative screening even in asymptomatic individuals [4]. Elective surgical populations provide an excellent opportunity for detailed assessment since evaluations can be performed without time pressure, facilitating the identification of subtle predictors [1,3].

However, variations in population profiles and resource availability create gaps in regional data, particularly in many secondary and tertiary hospitals where local patterns of airway difficulty remain insufficiently documented. Observational data from such centres are essential to refine institutional airway protocols, strengthen preparedness, and reduce perioperative risks [1–3].

The present observational study was designed to estimate the incidence of difficult airway among elective surgical patients and to examine the predictive performance of commonly used airway assessment parameters. By identifying reliable indicators, the study aims to strengthen preoperative screening protocols and enhance the safety of airway management in routine anesthesia practice.

Methodology

Study Design and Setting

This was a hospital-based observational cross-sectional study conducted in the Departments of Anaesthesiology at Government Medical College and General Hospital, Jagtial, and Government Medical College and General Hospital, Karimnagar, Telangana, India. The study was carried out over a 12-month period from June 2024 to May 2025. Adult patients scheduled for elective surgical procedures under general anesthesia were evaluated preoperatively for airway characteristics and followed intraoperatively for airway difficulty during laryngoscopy and intubation.

Study Population

All adult patients aged 18–65 years scheduled for elective surgery under general anesthesia with endotracheal intubation were screened for eligibility. Patients with maxillofacial trauma, congenital craniofacial anomalies, limited cooperation, unstable cervical spine, or requiring rapid sequence induction were excluded to ensure uniformity in preoperative assessment and intubation technique.

Sample Size

A total of **80 participants** were enrolled using consecutive sampling during the study period. Each patient underwent a standardized preoperative airway assessment.

Data Collection and Airway Assessment

Preoperative evaluation included:

Mallampati classification (I–IV)

Thyromental distance measured with a rigid ruler

Inter-incisor distance (mouth opening)

Cervical spine mobility assessed by active neck flexion and extension

Neck circumference measured at the level of the thyroid cartilage

All parameters were recorded by trained anesthesia residents under faculty supervision to minimize inter-observer variation.

Intraoperative Assessment

After induction of anesthesia using institutional standard protocols, laryngoscopy was performed using a Macintosh blade.

Difficult laryngoscopy was defined as Cormack–Lehane grade III or IV.

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Difficult intubation was defined as the need for more than two attempts, use of adjuncts beyond routine stylet, or intubation time exceeding 10 minutes.

Any perioperative adverse events such as desaturation (<92%), airway trauma, or need for alternative devices were documented.

Bias and Bias Control

To minimize selection bias, consecutive eligible patients meeting the inclusion criteria were enrolled during the study period. Standardized preoperative airway assessment protocols were used for all participants to reduce measurement bias. Assessments were performed by trained anesthesia residents under faculty supervision to limit inter-observer variability. Uniform induction and laryngoscopy techniques were followed as per institutional protocols to minimize performance bias. Data analysis was conducted using predefined criteria to reduce analytical bias.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 26. Descriptive statistics were expressed as mean ± standard deviation for continuous variables and as frequencies with percentages for categorical variables. Associations between categorical airway predictors and difficult airway were assessed using the chi-square test, while Fisher's exact test was applied when expected cell counts were less than five. Multivariate logistic regression analysis was performed to identify independent predictors of a difficult airway. A p-value <0.05 was considered statistically significant.

Ethical Considerations

Institutional Ethics Committee approval was obtained from both GMC Jagtial and GMC Karimnagar. Written informed consent was taken from all participants before inclusion.

Results

A total of 80 elective surgical patients were evaluated for airway characteristics and intraoperative difficulty. The baseline profile of the cohort is summarized in Table 1, showing a mean age of 44.8 ± 12.6 years and a male predominance (57.5%). Most individuals belonged to ASA Physical Status I–II, accounting for nearly three-quarters of the study population.

Table 1. Baseline Characteristics of the Study Population (n = 80)

Variable	Category	Frequency (n)	Percentage (%)
Age (years)	Mean ± SD	44.8 ± 12.6	—
Sex	Male	46	57.5
	Female	34	42.5
ASA Physical Status	I	35	43.7
	II	23	28.8
	III	22	27.5

Incidence of Difficult Airway

The overall incidence of difficult airway was 13.8%, with difficult laryngoscopy documented in 12.5% and difficult intubation in 8.8% of patients (Table 2). Among the 11 patients who experienced difficulty, nearly half represented unanticipated events.

Airway Assessment and Distribution of Difficulty

Preoperative airway assessment revealed that Mallampati Class III–IV was present in 32.5% of participants, while 18.7% had a thyromental distance <6.5 cm, and 10% demonstrated restricted mouth opening. As shown in Table 2, increased neck circumference (>40 cm) and limited cervical mobility were recorded in 15% and 10%, respectively.

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Table 2. Incidence and Airway Assessment Findings

Parameter	Category	Frequency (n)	Percentage (%)
Difficult airway (overall)	Yes	11	13.8
Difficult laryngoscopy	Yes	10	12.5
Difficult intubation	Yes	7	8.8
Mallampati class	I–II	54	67.5
	III–IV	26	32.5
Thyromental distance <6.5 cm	Present	15	18.7
Mouth opening <3.5 cm	Present	8	10
Restricted neck mobility	Present	8	10
Neck circumference >40 cm	Present	12	15

The distribution of difficult airway cases across key predictors is detailed in Table 3. A higher proportion of difficult events occurred among patients with Mallampati III–IV (72.7%), shortened thyromental distance (45.5%), and restricted neck movement (45.5%). Reduced mouth opening and larger neck circumference also contributed to notable proportions of difficult cases.

Table 3. Distribution of Difficult Airway Cases Across Predictive Variables (n = 11)

Predictor	Category	Difficult Airway (n)	Percentage within Difficult Cases (%)
Mallampati class III–IV	Yes	8	72.7
Thyromental distance <6.5 cm	Present	5	45.5
Mouth opening <3.5 cm	Present	3	27.3
Restricted neck movement	Present	5	45.5
Neck circumference >40 cm	Present	3	27.3

Association between Airway Predictors and Difficult Airway

Chi-square analysis demonstrated significant associations between difficult airway and several preoperative airway assessment parameters. Difficult airway was significantly more frequent among patients with Mallampati Class III–IV compared to Class I–II ($\chi^2 = 8.42$, $p = 0.004$). A reduced thyromental distance (<6.5 cm) was also significantly associated with a difficult airway ($\chi^2 = 7.36$, $p = 0.007$). Restricted cervical spine mobility showed a significant association with airway difficulty ($\chi^2 = 5.91$, $p = 0.015$). Reduced mouth opening (<3.5 cm) was significantly related to difficult airway ($\chi^2 = 4.62$, $p = 0.032$), as was increased neck circumference (>40 cm) ($\chi^2 = 4.18$, $p = 0.041$).

Predictors of Difficult Airway

On multivariate logistic regression analysis, two parameters emerged as the strongest independent predictors of difficult airway:

Thyromental distance <6.5 cm (Adjusted OR 4.2)
Mallampati Grade III–IV (Adjusted OR 3.6)

Other significant associations included reduced mouth opening, restricted neck mobility, and increased neck circumference (Table 4). These findings highlight the combined value of anatomical airway markers in anticipating difficulty during laryngoscopy and intubation.

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Table 4. Significant Predictors of Difficult Airway (Logistic Regression Analysis)

Predictor	Adjusted OR	95% CI	p-value
Mallampati III–IV	3.6	1.3–9.2	<0.05
Thyromental distance <6.5 cm	4.2	1.7–10.4	<0.01
Mouth opening <3.5 cm	2.8	1.1–7.3	<0.05
Restricted neck mobility	3.1	1.2–8.1	<0.05
Neck circumference >40 cm	2.4	1.0–5.8	<0.05

Perioperative Outcomes

Desaturation episodes (<92%) were observed in **3.7%** of patients, all belonging to the difficult airway group. No major airway trauma, aspiration, or emergency front-of-neck access was required in any case.

Discussion

This observational assessment revealed that a difficult airway occurred in a considerable proportion of elective surgical patients, with an incidence of 13.8%. This frequency aligns with international reports showing that difficult mask ventilation and intubation continue to present relevant perioperative challenges, even in settings where structured airway assessment is routinely practiced [10,11]. The rates of difficult laryngoscopy (12.5%) and difficult intubation (8.8%) observed here underscore the ongoing need for cautious preparation despite apparently favourable patient characteristics.

A prominent finding in this study was the clustering of difficult airway events among patients with Mallampati Class III–IV. Similar observations have been highlighted in systematic reviews demonstrating that higher Mallampati grades consistently increase the likelihood of difficult intubation due to restricted visualization of the oropharyngeal space [7]. Additional predictors identified in the present cohort—including reduced thyromental distance, limited mouth opening, impaired cervical spine mobility, and increased neck circumference—mirror established anatomical risk factors described in adult and mixed surgical populations [7,8]. The concentration of difficult airway cases within these variables reinforces the value of combining multiple bedside parameters rather than depending on any single assessment tool.

Multivariate analysis further demonstrated that Mallampati Class III–IV and thyromental distance <6.5 cm were the strongest independent predictors. Comparable findings have been reported in adult cohorts where structural constraints around the mandibular and upper airway region exert the greatest influence on laryngoscopic difficulty [7,8]. Although mouth opening and cervical mobility showed significant associations in crude analyses, their predictive strength diminished after adjustment, indicating that they function more reliably as secondary markers. This pattern aligns with growing evidence supporting integrated, multimodal scoring systems rather than isolated bedside tests [11,12].

The occurrence of mild desaturation exclusively among patients who experienced a difficult airway highlights the clinical relevance of accurate preoperative risk stratification. Even brief episodes of hypoxia can escalate rapidly when difficulty is unexpected, particularly in resource-limited environments. Similar concerns have been raised in paediatric and adult studies, where delays in securing the airway frequently increase the likelihood of transient oxygen desaturation [9,10]. These findings reinforce the importance of strategic planning, early positioning, availability of adjunct devices, and readiness to shift to alternative techniques when initial attempts fail.

A key strength of this study is its real-world applicability. Data were drawn from two active government medical colleges, reflecting typical surgical loads and diverse patient profiles encountered in many regions with limited access to advanced airway technologies. This strengthens the external relevance of the findings, consistent with earlier observational reports from similar environments in Africa and Asia [8,9].

Nevertheless, certain limitations must be acknowledged. The modest sample size reduces the precision of some estimates, and operator-related variability, although minimized through supervision, cannot be eliminated. Prior literature also emphasizes the growing role of ultrasonographic airway assessment, which may provide additional predictive value beyond bedside tests [12]. Larger multicentric studies incorporating such modalities may yield deeper insights and help refine predictive algorithms for routine practice.

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Overall, this study reiterates the ongoing importance of structured airway assessment in elective surgical care. The identification of reliable predictors, particularly high Mallampati grade and shortened thyromental distance, can meaningfully enhance preoperative preparation, reduce the likelihood of unanticipated difficulty, and strengthen perioperative safety across a wide range of clinical settings [7–12].

Generalizability

The findings of this study apply to adult elective surgical populations managed in comparable tertiary-care government hospitals with similar patient demographics and anesthetic practices. Because the study was conducted at two high-volume teaching institutions, the results reflect typical airway characteristics encountered in routine clinical settings. However, generalizability may be more limited in centers with highly specialized services, different ethnic compositions, or wider access to advanced airway technologies. Larger multicentric studies would help validate these predictors across broader surgical and geographic contexts.

Conclusion

This observational study highlights that a difficult airway continues to be a clinically significant concern among elective surgical patients, with a measurable incidence requiring careful anticipation. Preoperative assessment demonstrated that higher Mallampati grades, reduced thyromental distance, restricted mouth opening, limited neck mobility, and increased neck circumference were strongly associated with airway difficulty. Among these, Mallampati Class III–IV and thyromental distance <6.5 cm emerged as the most reliable independent predictors. Early recognition of these indicators enables better planning, timely preparation of adjuncts, and safer airway management. Strengthening routine airway evaluation can significantly reduce unexpected challenges and enhance perioperative safety in everyday anesthesia practice.

Limitations

This study was limited by its modest sample size, which restricts the precision of some estimates. Conducting the research at two government medical colleges creates a specific clinical context that does not capture variation seen in private or highly specialized centers. Operator experience differed slightly despite supervision, introducing potential performance-related variability. Advanced assessment tools such as airway ultrasound or video laryngoscopy were not included, reducing the opportunity to compare traditional predictors with newer diagnostic approaches.

Recommendations

Routine preoperative airway assessment should be strengthened by consistently incorporating multiple bedside predictors rather than relying on a single parameter. Patients with high-risk features, such as elevated Mallampati grade or reduced thyromental distance, should be identified early and managed with enhanced preparation, including ready access to adjuncts like bougies, stylets, and video-assisted devices. Regular simulation-based training for anesthesia teams is essential to reinforce preparedness for unexpected difficulty. Institutions should also standardize documentation of airway assessments and encourage periodic audits to improve clinical vigilance and refine airway management protocols across departments.

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Abbreviations

ASA – American Society of Anesthesiologists
OR – Odds Ratio
CI – Confidence Interval
cm – Centimeter
SD – Standard Deviation
SPSS – Statistical Package for the Social Sciences
ECG – Electrocardiogram
BMI – Body Mass Index
IC – Inter-incisor Distance
NC – Neck Circumference

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Conflict of interest

The authors declare no conflict of interest.

Author's contribution

SKK-Concept and design of the study, results interpretation, review of literature, and preparing the first draft of the manuscript. Statistical analysis and interpretation, revision

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of manuscript.**AG**-Design of the study, results interpretation, review of literature, and preparing the first draft of the manuscript. Statistical analysis and interpretation, revision of manuscript.

Data Availability

Data Available on request

Author Biography

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