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Original Article

Incidence and Determinants of Difficult Laryngoscopy in Adult Patients Undergoing General Anaesthesia: A Hospital-Based Observational Study

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ABSTRACT

Background: Difficult laryngoscopy can delay tracheal intubation and increase the risk of hypoxaemia and airway trauma. Reliable preoperative recognition permits appropriate preparation and early use of alternative airway devices.
Objectives: To determine the incidence of difficult laryngoscopy and identify demographic, clinical, and airway-related determinants among adults undergoing elective surgery under general anaesthesia.
Methods: This hospital-based prospective observational study included 60 adults undergoing elective surgery with direct laryngoscopy at Seth G.S. Medical College and King Edward Memorial Hospital, Mumbai, from April to July 2025. Preoperative assessment included modified Mallampati class, mouth opening, thyromental and sternomental distances, neck circumference, neck extension, body mass index, and history of snoring. Difficult laryngoscopy was defined as Cormack-Lehane grade III or IV. Associations were examined using univariable tests and exploratory multivariable logistic regression.
Results: Difficult laryngoscopy occurred in 13 patients, giving an incidence of 21.7% (95% confidence interval: 13.1-33.6%). Patients with difficult laryngoscopy were older and had a higher mean body mass index. Mallampati class III-IV, thyromental distance below 6.5 cm, sternomental distance below 12.5 cm, restricted neck extension, mouth opening below 3.5 cm, neck circumference of at least 40 cm, obesity, and snoring were significantly associated with difficulty. Mallampati class III-IV and reduced thyromental distance remained independent determinants. The prediction model had an area under the receiver operating characteristic curve of 0.89. Difficult laryngoscopy was associated with longer laryngoscopy, repeated attempts, adjunct use, desaturation, and mucosal trauma.
Conclusion: Difficult laryngoscopy was frequent in this hospital cohort. A combined assessment, particularly incorporating Mallampati class and thyromental distance, provided clinically useful risk stratification.

Keywords*: airway assessment; Cormack-Lehane grade; difficult laryngoscopy; general anaesthesia; Mallampati classification; thyromental distance.*

INTRODUCTION

Airway management is a central component of general anaesthesia, and direct laryngoscopy followed by tracheal intubation remains a common technique for securing the airway during surgery. Failure to obtain an adequate laryngeal view can prolong airway instrumentation, increase the number of intubation attempts, and expose patients to hypoxaemia, aspiration, haemodynamic instability, dental injury, and soft-tissue trauma. Contemporary difficult-airway guidelines therefore emphasise structured preoperative assessment, adequate positioning and preoxygenation, limitation of repeated attempts, and timely transition to alternative devices when difficulty is encountered [1,2].

The Cormack-Lehane classification provides a practical description of the laryngeal view obtained during direct laryngoscopy. Grades I and II generally indicate adequate glottic visualisation, whereas grades III and IV represent difficult laryngoscopy because the vocal cords are not visible [3]. Although difficult laryngoscopy and difficult tracheal intubation are not identical outcomes, impaired laryngeal visualisation is a major contributor to repeated instrumentation and unsuccessful first-pass intubation. Estimating its frequency within individual institutions is useful because patient characteristics, surgical case mix, operator experience, equipment availability, and definitions vary across settings.

Numerous bedside tests have been proposed to identify patients at risk. Commonly used measures include the modified Mallampati classification, thyromental distance, sternomental distance, interincisor gap, neck circumference, mandibular protrusion, and cervical spine mobility. However, meta-analyses have shown that individual tests usually provide high specificity but limited sensitivity, and no single examination reliably excludes a difficult airway [4,5]. A recent systematic review involving a broad range of prediction approaches reached a similar conclusion and supported combining clinical history with multiple anatomical measurements rather than relying on one test alone [6].

Prediction also remains imperfect in routine practice. Large database studies have reported that many difficult intubations are not anticipated by the attending anaesthesiologist [7]. Multivariable tools were developed to integrate several modest predictors and improve risk stratification [8]. Even widely used markers require cautious interpretation: Mallampati class performs poorly as a stand-alone screening test [9,10], while obesity is associated with increased airway difficulty but has limited discriminatory ability when considered in isolation [11,12]. Local observational evidence is therefore valuable for identifying the combination of factors most relevant to a specific patient population and clinical environment.

The present study was undertaken to determine the incidence of difficult laryngoscopy among adult patients undergoing elective surgery under general anaesthesia at a tertiary-care teaching hospital. The study also aimed to examine demographic, clinical, and preoperative airway characteristics associated with difficult laryngoscopy; identify independent determinants using exploratory multivariable analysis; and describe related intubation requirements and immediate airway complications.

MATERIALS AND METHODS

Study design and setting

This prospective hospital-based observational study was conducted in the Department of Anaesthesiology at Seth G.S. Medical College and King Edward Memorial Hospital, Parel, Mumbai, Maharashtra, India, from April 2025 to July 2025. The study was reported in accordance with principles applicable to observational research. Necessary Permissions were obtained before starting the study, and written informed consent was obtained from every participant.

Participants

Adults aged 18-75 years, belonging to American Society of Anesthesiologists physical status I-III, who were scheduled for elective surgery under general anaesthesia requiring oral endotracheal intubation by direct laryngoscopy were eligible. Patients undergoing emergency surgery, those requiring rapid-sequence or awake intubation, patients with known craniofacial anomalies, upper-airway tumours, cervical spine instability, previous major head-and-neck surgery, or incomplete assessment records were excluded. Consecutive eligible patients were enrolled. Assuming an anticipated difficult-laryngoscopy prevalence of 10%, 95% confidence level, 8% absolute precision, and 10% allowance for exclusions or incomplete data, the planned sample size was 60.

Preoperative assessment

On the day before surgery, an anaesthesiologist who was not responsible for grading the laryngoscopic view recorded age, sex, body mass index, American Society of Anesthesiologists physical status, and history of habitual snoring. Airway examination included modified Mallampati class in the seated position without phonation, maximal interincisor distance, thyromental distance with full neck extension, sternomental distance, neck circumference at the thyroid cartilage, and cervical extension. Prespecified adverse findings were Mallampati class III-IV, mouth opening below 3.5 cm, thyromental distance below 6.5 cm, sternomental distance below 12.5 cm, neck circumference at least 40 cm, and restricted neck extension. These measures were selected from established multivariable and bedside airway assessment approaches [8,13].

Anaesthetic and laryngoscopy procedure

Standard monitoring, intravenous induction, neuromuscular blockade, mask ventilation, and preoxygenation were provided according to departmental practice. After adequate neuromuscular relaxation, direct laryngoscopy was performed in the sniffing position using a Macintosh blade by an anaesthesiologist with at least three years of airway-management experience. The best laryngeal view before external laryngeal manipulation was graded according to the Cormack-Lehane classification [3]. Grades I-II were categorised as easy laryngoscopy and grades III-IV as difficult laryngoscopy. The number of attempts, laryngoscopy duration, external laryngeal manipulation, bougie or

videolaryngoscope use, oxygen desaturation below 94%, mucosal trauma, failed intubation, and emergency surgical airway were recorded.

Statistical analysis

Data were analysed using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean and standard deviation and compared using the independent-samples t-test. Categorical variables were reported as frequency and percentage and analysed using the chi-square test or Fisher exact test. Univariable odds ratios with 95% confidence intervals were calculated. Because only 13 outcome events occurred, an exploratory logistic regression model was restricted to three clinically selected variables. Model discrimination was assessed using the area under the receiver operating characteristic curve and calibration using the Hosmer-Lemeshow test. A two-sided p value below 0.05 was considered statistically significant.

RESULTS

Participant recruitment and study population

During the study period, 64 adult patients scheduled to undergo elective surgery under general anaesthesia were assessed for eligibility. Four patients were excluded: two did not fulfil the eligibility criteria, one declined participation, and one had incomplete airway assessment data. The remaining 60 patients were enrolled and included in the final analysis. Complete preoperative airway, intraoperative laryngoscopic, and intubation data were available for all participants.

Incidence of difficult laryngoscopy

Difficult laryngoscopy, defined as a Cormack-Lehane grade III or IV laryngeal view during direct laryngoscopy, was observed in 13 of the 60 patients. The overall incidence was 21.7% (95% confidence interval [CI]: 13.1-33.6%). The remaining 47 patients (78.3%) had Cormack-Lehane grade I or II views and were classified as having easy laryngoscopy. Grade I was documented in 26 (43.3%) patients, grade II in 21 (35.0%), grade III in 10 (16.7%), and grade IV in 3 (5.0%) patients.

Demographic and clinical characteristics

The mean age of the study population was 46.2 +/- 13.0 years, with an age range of 18-72 years. Thirty-four (56.7%) patients were males and 26 (43.3%) were females. The mean body mass index was 25.7 +/- 4.0 kg/m², and obesity was present in 11 (18.3%) patients. Patients with difficult laryngoscopy were significantly older than those with easy laryngoscopy (52.8 +/- 11.4 versus 44.4 +/- 13.0 years; p = 0.033). Mean body mass index was also significantly higher in the difficult-laryngoscopy group (28.8 +/- 3.8 versus 24.8 +/- 3.7 kg/m²; p = 0.003). Sex distribution and American Society of Anesthesiologists physical status were comparable between the groups (Table 1).

Table 1. Demographic and clinical characteristics according to laryngoscopy difficulty

Characteristic	Easy laryngoscopy (n = 47)	Difficult laryngoscopy (n = 13)	p value
Age, years	44.4 +/- 13.0	52.8 +/- 11.4	0.033
Male sex	26 (55.3)	8 (61.5)	0.760
Female sex	21 (44.7)	5 (38.5)	
Body mass index, kg/m²	24.8 +/- 3.7	28.8 +/- 3.8	0.003
Obesity, BMI >=30 kg/m²	4 (8.5)	7 (53.8)	0.001
ASA physical status I	27 (57.4)	4 (30.8)	0.121
ASA physical status II-III	20 (42.6)	9 (69.2)	
History of snoring	9 (19.1)	7 (53.8)	0.029

Values are presented as mean +/- standard deviation or number (percentage). ASA: American Society of Anesthesiologists; BMI: body mass index.

Preoperative airway assessment

Mallampati class III or IV was observed in 17 (28.3%) patients. A thyromental distance below 6.5 cm was found in 15 (25.0%), while a sternomental distance below 12.5 cm was present in 12 (20.0%) patients. Restricted neck extension was documented in 10 (16.7%), mouth opening below 3.5 cm in 9 (15.0%), and neck circumference of at least 40 cm in 14 (23.3%) patients. Mallampati class III-IV and a reduced thyromental distance were markedly more frequent among patients with difficult laryngoscopy. Restricted neck extension, reduced sternomental distance, limited mouth opening, increased neck circumference, obesity, and snoring were also significantly associated with difficult laryngoscopy (Table 2).

Table 2. Association between preoperative airway characteristics and difficult laryngoscopy

Airway characteristic	Easy (n = 47)	Difficult (n = 13)	Unadjusted OR (95% CI)	p value
Mallampati class III-IV	7 (14.9)	10 (76.9)	19.05 (4.17-87.07)	<0.001
Thyromental distance <6.5 cm	6 (12.8)	9 (69.2)	15.38 (3.58-65.97)	<0.001

Sternomental distance <12.5 cm	5 (10.6)	7 (53.8)	9.80 (2.34-41.01)	0.002
Restricted neck extension	4 (8.5)	6 (46.2)	9.21 (2.06-41.14)	0.004
Mouth opening <3.5 cm	4 (8.5)	5 (38.5)	6.72 (1.48-30.60)	0.018
Neck circumference >=40 cm	7 (14.9)	7 (53.8)	6.67 (1.72-25.82)	0.007
Obesity, BMI >=30 kg/m²	4 (8.5)	7 (53.8)	12.54 (2.81-56.00)	0.001
History of snoring	9 (19.1)	7 (53.8)	4.93 (1.33-18.26)	0.029

Values are presented as number (percentage). CI: confidence interval; OR: odds ratio.

Laryngoscopy and intubation characteristics

Successful tracheal intubation during the first attempt was achieved in 47 (78.3%) patients. Nine (15.0%) patients required two attempts and four (6.7%) required three attempts. No failed tracheal intubation or emergency surgical airway occurred. Among the 13 patients with difficult laryngoscopy, a bougie was used in 10, videolaryngoscopy was required in three, and external laryngeal manipulation was performed in nine. All patients were successfully intubated using the predefined difficult-airway protocol. The mean laryngoscopy duration was significantly longer in patients with difficult laryngoscopy (31.6 +/- 8.9 versus 18.4 +/- 5.6 seconds; $p < 0.001$). Transient oxygen desaturation below 94% occurred in three patients, all in the difficult-laryngoscopy group. Minor oral or pharyngeal mucosal trauma occurred in five patients, including four with difficult laryngoscopy. No aspiration, dental injury, severe hypoxaemia, cardiac arrest, or airway-related mortality occurred (Table 3).

Table 3. Laryngoscopy, intubation, and airway-related outcomes

Outcome	Easy laryngoscopy (n = 47)	Difficult laryngoscopy (n = 13)	p value
Laryngoscopy duration, seconds	18.4 +/- 5.6	31.6 +/- 8.9	<0.001
First-attempt intubation success	47 (100.0)	0 (0.0)	<0.001
Two intubation attempts	0 (0.0)	9 (69.2)	<0.001
Three intubation attempts	0 (0.0)	4 (30.8)	<0.001
Bougie requirement	0 (0.0)	10 (76.9)	<0.001
Videolaryngoscope requirement	0 (0.0)	3 (23.1)	0.008
Oxygen desaturation <94%	0 (0.0)	3 (23.1)	0.008
Mucosal trauma	1 (2.1)	4 (30.8)	0.006
Failed intubation	0 (0.0)	0 (0.0)	-

Values are presented as mean +/- standard deviation or number (percentage).

Multivariable analysis of determinants

Variables with clinically relevant or statistically significant univariable associations were considered for exploratory multivariable logistic regression. Mallampati class III-IV and thyromental distance below 6.5 cm remained independently associated with difficult laryngoscopy. Mallampati class III-IV was associated with approximately sevenfold greater adjusted odds of difficult laryngoscopy (adjusted odds ratio [aOR]: 7.46; 95% CI: 1.38-40.25; $p = 0.019$), while a reduced thyromental distance was associated with more than sixfold greater adjusted odds (aOR: 6.21; 95% CI: 1.23-31.42; $p = 0.027$). Obesity showed increased adjusted odds but did not retain statistical significance (Table 4).

Table 4. Multivariable logistic regression analysis of determinants of difficult laryngoscopy

Determinant	Adjusted OR	95% CI	p value
Mallampati class III-IV	7.46	1.38-40.25	0.019
Thyromental distance <6.5 cm	6.21	1.23-31.42	0.027
Obesity, BMI >=30 kg/m²	3.14	0.62-15.95	0.168

CI: confidence interval; OR: odds ratio.

The final prediction model demonstrated good discriminatory ability, with an area under the receiver operating characteristic curve of 0.89 (95% CI: 0.80-0.98). The Hosmer-Lemeshow goodness-of-fit test indicated satisfactory calibration ($p = 0.742$).

DISCUSSION

In this prospective cohort of adults undergoing elective surgery, difficult laryngoscopy occurred in 21.7% of participants. This frequency is higher than that reported in several large mixed surgical populations, although estimates vary substantially according to patient selection, operator expertise, laryngoscopy technique, and the outcome definition used. Studies defining difficulty by Cormack-Lehane grade III-IV often report a broader outcome than studies based on failed or multiple-attempt intubation. The present estimate should therefore be interpreted as the incidence of difficult direct laryngeal visualisation within this hospital cohort rather than a population-wide rate [3,4,14].

Higher Mallampati class and reduced thyromental distance were the strongest independent determinants. These findings are anatomically plausible. Mallampati class reflects the relationship between tongue volume and the visible oropharyngeal space, while thyromental distance represents mandibular space and the potential for displacement of the tongue during laryngoscopy. Earlier meta-analyses found that both tests have limited sensitivity when used separately, but their combined application improves clinical discrimination [4-6]. The present findings support a composite assessment rather than reliance on an isolated bedside measure. The wide confidence intervals, however, show the uncertainty created by the limited number of difficult-laryngoscopy events.

Reduced sternomental distance, limited mouth opening, restricted neck extension, and increased neck circumference were also associated with difficulty in univariable analysis. Each factor represents a distinct mechanical constraint: inadequate mandibular space, restricted insertion and manipulation of the laryngoscope, impaired alignment of airway axes, or increased anterior neck soft tissue. These observations are consistent with multivariable airway indices and systematic reviews demonstrating that prediction improves when several anatomical domains are assessed together [5,8,10]. Upper-lip and mandibular mobility tests have also shown useful specificity in previous prospective studies, reinforcing the value of evaluating jaw movement alongside static measurements [13,14].

Obesity was strongly associated with difficult laryngoscopy before adjustment but did not remain statistically significant in the exploratory regression model. Large cohort and meta-analytic evidence indicates that elevated body mass index increases the risk of difficult laryngoscopy or intubation, yet body mass index alone is a weak screening tool [11,12]. Neck circumference and local fat distribution probably capture airway-related anatomy more directly than overall body size. Habitual snoring was also associated with difficulty, potentially reflecting upper-airway collapsibility and altered pharyngeal anatomy, but it was not included in the restricted model.

Difficult laryngoscopy had immediate procedural consequences. It was accompanied by longer laryngoscopy time, repeated attempts, frequent bougie or videolaryngoscope use, desaturation, and mucosal trauma. These findings highlight the clinical importance of early recognition, optimal preoxygenation, experienced assistance, and ready access to rescue devices. Current guidelines recommend limiting repeated attempts and progressing promptly to an alternative technique to preserve oxygenation and reduce airway injury [1,2].

LIMITATIONS

This study was conducted at a single tertiary-care hospital and included only 60 elective surgical patients, limiting external validity. The 13 difficult-laryngoscopy events produced wide confidence intervals and restricted the multivariable model to three predictors. Operator-dependent grading and bedside measurements introduced potential observer variability. Emergency cases, patients selected for awake intubation, and those with major anatomical abnormalities were excluded; therefore, the findings do not represent every difficult-airway population.

CONCLUSION

Difficult laryngoscopy was identified in approximately one-fifth of adults undergoing elective surgery under general anaesthesia in this tertiary-care hospital. Mallampati class III-IV and thyromental distance below 6.5 cm were independent determinants, while obesity, increased neck circumference, restricted neck extension, reduced sternomental distance, limited mouth opening, and snoring were important associated findings. Difficult laryngoscopy increased procedural time, intubation attempts, adjunct use, desaturation, and minor airway trauma. A structured preoperative assessment incorporating several complementary anatomical and clinical variables is preferable to dependence on a single screening test. Early identification of higher-risk patients can support preparation, experienced assistance, effective preoxygenation, and timely deployment of alternative airway devices during anaesthetic practice and improve safety.

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