

# Assessment of Airway Parameters for Predicting Difficult Laryngoscopy and Intubation in a Tertiary Center in Western Nepal

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## ABSTRACT

**Background:** The screening tests used for pre-operative evaluation of airway to predict difficult laryngoscopy and intubation have variable diagnostic accuracy. The unanticipated poor laryngeal view is gold standard for defining difficult intubation. We aimed to find out the prevalence of difficult laryngoscopy and intubation, which airway parameter better predicts difficult intubation and whether difficult laryngoscopy is associated with difficult intubation or not.

**Methods:** This analytic cross sectional study was conducted in 665 ASA I/II adult patients, aged 18-65, without obvious airway pathology undergoing elective surgery under general anesthesia. The pre-operative screening tests included mouth opening, modified mallampatti, ratio of height to thyromental distance, sternomental distance and upper lip bite test. Cormack-Lehane grade III/ IV was defined as difficult laryngoscopy and potentially difficult intubation. Sensitivity, specificity, positive predictive value, negative predictive value, accuracy and area under curve at 95% confidence interval was calculated for all five screening tests.

**Results:** The prevalence of difficult laryngoscopy and intubation was 6.6% (44 cases). The upper lip bite test because of its highest specificity, positive predictive value, negative predictive value, accuracy and area under curve (99.7%; 93.9%; 99.7%; 95.2%; 85.1% respectively) with moderate level of sensitivity (70.5%) was better predictor of difficult intubation than other tests. The difficult laryngoscopy was associated with difficult intubation ( $p=0.00$ ).

**Conclusions:** The prevalence of difficult laryngoscopy and intubation was 6.6%. The upper lip bite test was a better predictor of difficult intubation and there was a significant association of difficult laryngoscopy with difficult intubation.

**Keywords:** Difficult laryngoscopy and intubation; screening tests; upper lip bite test.

## INTRODUCTION

The evaluation of airway prior to general anesthesia and surgery is a common practice in anesthesia. This gives an opportunity to diagnose if any difficulty would arise during airway management. Depending on the outcome of airway assessment, airway would be graded as easy or difficult. The preparedness will be there in cases of anticipated difficulty whereas managing an unanticipated difficult airway is challenging even for an experienced anesthesiologist.

There are various bedside tests which have been used for predicting difficult laryngoscopy and intubation (DLI), like mouth opening, modified mallampatti (MMP), ratio of height to thyromental distance (RHTMD), sternomental distance (SMD) and upper lip bite test (ULBT). However, no single test has been proven to correctly diagnose it.

The aim of this study was to find out the prevalence of DLI, which airway parameter better predicts difficult intubation (DI) and whether difficult laryngoscopy (DL) is associated with DI or not.

## METHODS

This analytic cross-sectional study was conducted in the Department of Anesthesiology of Manipal Teaching Hospital, Pokhara, Nepal from September 2018-August 2019. The approval from institutional review board and written and informed consent was obtained. A total of 665 ASA I and II adult patients of both gender, aged 18-65 scheduled for various elective surgical procedures under general anesthesia were enrolled in the study. Patients with anticipated difficult airway as facial burn, past history of surgery of face, neck, pharynx, larynx, radiotherapy of neck, thyroid swelling, maxillofacial

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trauma, BMI  $\geq$  30 kg/m<sup>2</sup> and parturient were excluded.

The prevalence of difficult airway has been reported to range from 0.05-18%.<sup>1</sup> Considering the prevalence as 10% with margin of error of 2%, the sample size was calculated as:  $n \geq z^2pq/d^2$ , where n: no of cases, z: 1.96 at 90% confidence interval, p: prevalence of difficult airway= 0.1, q: 1-p=0.9, d: allowable error= 0.02, the minimum sample size calculated was 609, however we have enrolled 665 cases and sampling was done by simple random sampling technique.

Preoperative airway evaluation of all the patients were done by the first author in the pre-operative waiting room. The following parameters were assessed: Mouth opening: It was defined as the distance between the upper and lower incisor. It was measured with graduated metal scale with patient in sitting position and mouth widely open, Modified Mallampati (MMP): It was divided into four grades: Grade I: Visualization of the soft palate, fauces; uvula, anterior and the posterior tonsillar pillars, Grade II: Visualization of the soft palate, fauces and uvula, Grade III: Visualization of soft palate and base of uvula, Grade IV: Visualization of the hard palate only. Soft palate is not visible at all. It was evaluated with the patient in sitting position, head in neutral position and mouth widely open without phonation and tongue protruded maximally, Ratio of height to thyromental distance (RHTMD): The thyromental distance was measured from thyroid notch to the tip of the mentum with graduated metal scale with the patient in sitting position, neck in full extension and mouth closed, the height was measured in centimeters and the ratio of height to thyromental distance was calculated, Sternomental Distance (SMD): It was measured with graduated metal scale from suprasternal notch to tip of mentum with neck of the patient in full extension and mouth closed, and Upper lip bite test (ULBT): It was divided into three classes as: Class A: Lower incisor could bite upper lip above vermilion line, Class B: Lower incisors could bite upper lip below vermilion line, Class C: Lower incisors could not bite the upper lip. The results of the pre-operative screening tests were divided into two grades for the prediction of easy or difficult laryngoscopy and intubation as shown in Table 1.

**Table 1. Grading of airway.**

Airway parameters	Easy	Difficult
1. Mouth opening	>3cms	<3 cms
2. MMP	Grade I and II	Grade III and IV
3. RHTMD	<23.5	>23.5
4. SMD	>12.5 cms	<12.5 cms
5. ULBT	Class A and B	Class C

General anesthesia was standardized for all patients. After pre-oxygenation with 100% oxygen for three minutes, induction was done with injection fentanyl 1-2 µg/kg and injection propofol 2-3 mg/kg. Muscle relaxation was achieved with injection succinylcholine 2 mg/kg. After 90 seconds of assisted ventilation, direct laryngoscopy and endotracheal intubation was done with polyvinylchloride endotracheal tube (ETT) of size 8mm ID and 7mm ID for male and female patients respectively. The cuff was inflated and the correct position of the ETT verified. Heart rate, electrocardiogram, arterial oxygen saturation, non-invasive blood pressure and temperature were monitored in all patients.

Direct laryngoscopy was performed with proper sized Macintosh blade in sniffing position. The glottis exposure was graded as per Cormack-Lehane (CL) classification.<sup>1,2</sup>

Grade I: Full view of glottis, Grade II: visibility of posterior extremity of glottis only, Grade III: visibility of epiglottis only, none of glottis seen and Grade IV: Neither glottis nor epiglottis seen.

CL grade I/II was graded as easy and III/IV was graded as difficult laryngoscopy and potentially difficult intubation.

Laryngoscopy and intubation were performed by second and third author who were not aware about the results of preoperative airway screening tests. Both the authors have > three years of experience in anesthesia.

The following parameters were noted: number of attempts of laryngoscopy and intubation, use of external laryngeal manipulation, stylet, boogie, change of laryngoscope blade or change of laryngoscope and change of the operator.

Statistical analysis was done using SPSS (SPSS Inc., Chicago, IL, version 21.0 for windows). Quantitative data are presented as mean  $\pm$  sd and evaluated using independent t test. Qualitative data are presented as number/percentages and evaluated using chi square/ fischer's exact test whichever was applicable. Sensitivity, specificity, positive predictive value, negative predictive value, accuracy and area under curve (95% confidence interval) was calculated for each test. Receiver operating characteristic curve was also plotted for each test with sensitivity against 1- specificity. P value  $\leq$  0.05 was considered statistically significant.

**RESULTS**

A total of 665 cases were enrolled in the study. Difficult laryngoscopy and intubation (DLI) was present in

6.6% (44 cases). There were no cases of CL grade IV. We were able to intubate all the cases. The attempts of laryngoscopy and attempts to intubate the trachea was more in cases with CL grade III (p=0.00) (Table 2). Difficult laryngoscopy was also associated with difficult intubation (p=0.00).

**Table 2. Prevalence of difficult laryngoscopy and intubation.**

SN	Total	CL I/II: Easy	CL III: Difficult	p value
<b>Attempts of laryngoscopy</b>				
1	645/96.9%	611/98.4%	34/77.3%	0.00
2	17/2.7%	10/1.6%	7/15.9%	
3	3/0.4%	0/0%	3/6.8%	
<b>Attempts of intubation</b>				
1	633/95.2%	604/97.3%	29/65.9%	0.00
2	24/3.6%	15/62.5%	9/20.5%	
3	7/1.1%	2/28.6%	5/11.4%	
4	1/0.2%	0/0.0%	1/2.3%	

The intubation aid as external laryngeal manipulation (ELM) and stylet were used in 93.18% (41 cases) and 13.6% (six cases) of DLI respectively.

There were no incidences of use of boogie, change of laryngoscope blade, change of laryngoscope and change of operator.

The distribution of pre-operative screening test based on Cormack-Lehanelaryngoscopic grading is given in Table 3.

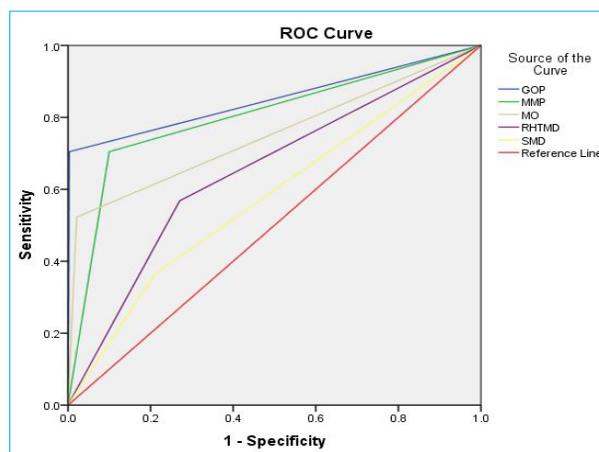
Table 4 reports the predictive value of screening tests. Modified mallampatti (MMP) and upper lip bite test (ULBT) had highest sensitivity followed by ratio of height to thyromental distance (RHTMD) and mouth opening (MO), and Sternomental distance (SMD) had least sensitivity. Specificity was good for all tests. Positive predictive value (PPV) was highest for ULBT and worst for SMD. Negative predictive value (NPV) was high for all

tests. The accuracy of ULBT, MO and MMP was high; SMD and RHTMD was moderate.

Receiver operating characteristic (ROC) curves were constructed (Figure 1) and area under curve (AUC) for each test was calculated. AUC was highest for ULBT (85.1%) (Table 4).The patient characteristics are tabulated in Table 5.

**Table 3. Pre-operative screening tests with respect to CL grade.**

Screening tests	Total	CL I/II: Easy	CL I/II: Difficult
MO >3 cm (Easy)	629/94.6%	608	21
<3 cm (Difficult)	36/5.4%	13	23
MMP I/ II (Easy)	580/87.2%	562	21
III/ IV (Difficult)	85/12.8%	59	23
RHTMD <23.5 (Easy)	472/71%	453	19
>23.5 (Difficult)	193/29%	168	25
SMD >12.5 (Easy)	519/78%	491	28
<12.5 (Difficult)	146/22%	130	16
ULBT Class A/B (Easy)	632/95%	619	13
Class C (Difficult)	33/5%	2	31



**Figure 1. Receiver operating characteristics (ROC) curve.**

**Table 4. Predictive values of pre-operative screening tests.**

Airway parameters	Sn	Sp	PPV	NPV	Accuracy	AUC (95%CI)
1. MO	52.3%	97.9%	63.9%	96.7%	94.8%	75.1% (0.65-0.84)
2. MMP	70.5%	90%	33.3%	97.7%	87.5%	80.2% (0.72-0.88)
3. RHTMD	56.8%	72.9%	13%	96%	71.8%	64.9% (0.56-0.73)
4. SMD	36.4%	79.1%	11%	94.6%	76.2%	57.7% (0.48-0.66)
5. ULBT	70.5%	99.7%	93.9%	99.7%	95.2%	85.1% (0.76-0.93)

Table 5. Patient characteristics with respect to CL grade.

Variables	Overall Value	CL: Easy I / II	CL: Difficult III	P value
Age (year)	41.50 ± 13.91	41.03 ± 13.81	48.16 ± 13.70	0.00
BMI (kg/m <sup>2</sup> )	24.83 ± 4.41	21.80 ± 2.34	28.84 ± 3.11	0.00
Gender (%)				
Male	257/ 38.6%	241/ 93.8%	16/ 6.2%	0.74
Female	408/ 61.4 %	380/ 93.1%	28/ 6.9%	

## DISCUSSION

The pre-operative evaluation of airway for prediction of difficult laryngoscopy and intubation (DLI) has always been prioritized in anesthesia. The correct prediction can prevent the potential complications which can range from minor airway injury, transient hypoxia to severe airway injury, brain injury and even death.

There is a wide variation in the reported incidence of DLI (0.05-18%) due to lack of uniformity in definition of DLI based on attempts of laryngoscopy, intubation, use of alternative techniques as external laryngeal manipulation and stylet even on studies based on Cormack-Lehane's laryngoscopic grade. In our study we found the incidence of DLI was 6.6% which was similar to past studies.<sup>1, 3-5</sup>

Likewise, difficult intubation has been defined in several ways. The unanticipated poor glottis view on direct laryngoscopy is considered as a gold standard for defining difficult intubation.<sup>1,6-8</sup> We have followed this same definition in our study.

To predict DLI with a screening test is challenging and there has been variability in reported sensitivity and specificity of tests.

Among the predictors we evaluated, upper lip bite test (ULBT) because of its highest specificity, positive predictive value (PPV), negative predictive value (NPV), good sensitivity and high accuracy was a better predictor of DLI as compared to other screening tests.

The sensitivity, specificity, and accuracy of the ULBT; 70.5%, 99.7% and 93.9% respectively were similar to those reported by the previous researchers Khan et al (78.95%, 91.96% and 91.05%, respectively), Ali et al (87.5%, 92.9% and 91.9% respectively) and Khan et al (76.5%, 88.7% and

88%, respectively).<sup>9-11</sup>

ULBT evaluates the mandibular movement and architecture of the teeth, both the parameters bear an important role in laryngoscopy and intubation. It was introduced by Khan et al as a good predictor for DLI and our study results are similar to their findings.<sup>9</sup>

The high specificity and negative predictive value (NPV) of ULBT, indicate that easy grade of ULBT (Class A/B) is more likely to predict easy laryngoscopy and tracheal intubation.

In addition, ULBT also had high positive predictive value (PPV) (93.9%), which implies that only few patients with difficult airway would be graded as easy.

The area under Receiver Operating Characteristic (ROC) curve which is a measure of accuracy and discriminative power of a diagnostic test, was also highest for ULBT (85.1%) which makes it a better predictor for diagnosing DLI as compared to other tests.

Our findings are concurrent with past studies.<sup>3,9,12-13</sup> The Class C; the difficult grade of ULBT was present in 5% (33 cases) in our study which is similar to that mentioned in literature (2%-21%).<sup>14</sup>

The modified mallampatti (MMP) also had a good sensitivity in predicting DLI which is in accordance with the past studies.<sup>3,15-16</sup>

Additionally, we found that other screening tests had low to moderate sensitivity (36-56%) in predicting DLI. This also highlights the possibility of missing the cases of DLI when the screening tests are used alone. Thus the past studies recommend that preoperative airway has to be evaluated using various sets of screening tests to increase the probability of diagnosing a case of difficult airway.<sup>17</sup>

Except for ULBT; PPV for predicting DLI of the screening tests were poor similar to past study.<sup>10</sup> The NPV was more than 90% for all tests showing the probability that if patients test negative, endotracheal intubation is likely to be easy.

The demographics of easy and difficult intubation show that variables such as age and body mass index (BMI) were significant contributors for difficult intubation. This has been confirmed by past studies as well.<sup>4,18</sup>

A small sample size is one of our limitations. We have not included pediatric and obstetric patients in our study.

## CONCLUSIONS

The incidence of difficult laryngoscopy and intubation was 6.6% (44 cases). The upper lip bite test because of its acceptable sensitivity, highest specificity, positive predictive value, negative predictive value and accuracy was a better predictor of difficult intubation as compared to other tests and there was a significant association of difficult laryngoscopy with difficult intubation.

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