

# UPPER LIP BITE TEST AS A PREDICTOR OF DIFFICULT MASK VENTILATION: A PROSPECTIVE STUDY

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## Forwarding comments

Failure to recognize a difficult airway before routine induction of anesthesia, can bring in its wake disastrous complications ranging from hypoxic brain damage to death. Several preoperative airway assessment tests exist that help in anticipating difficult airway. The upper lip bite test (ULBT) introduced by Khan et al<sup>3</sup> almost 20 years after Mallampati classification, is perhaps the latest in predicting difficulty in endotracheal intubation.

ULBT test is performed according to the following criteria: class I = lower incisors can bite the upper lip above the vermilion line, class II = lower incisors can bite the upper lip below the vermilion line, class III = lower incisors cannot bite the upper lip. Based on its high Se, Sp and NPV obtained in the original study<sup>3</sup>, we hypothesized that the ULBT could serve as a predictor of difficult mask ventilation (DMV).

DMV continues to be a major cause of morbidity and mortality with an increased incidence of almost 5%. Five preoperative risk factors (age older than 65 yr, body mass index  $\geq 26$  kg/m<sup>2</sup>, presence of a beard, lack of teeth and history of snoring), have been considered to be independently associated with DMV. As DMV has been found to be significantly associated with difficult intubation, the ULBT with its inherently high level of accuracy in correctly predicting a high percentage of easy and difficult intubations in the original study by the author<sup>3</sup>, appeared to be promising in predicting DMV, as the test assesses both buck teeth and mandibular subluxation simultaneously, factors that can be of vital importance in assessing DMV.

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## Abstract

**Background:** Oxygenation and ventilation by means of bag-mask and ambubag play a significant role in maintaining an optimal oxygen saturation of blood and hence the essence of life itself. Predicting difficulty in mask ventilation is again of paramount importance at the time of induction of anesthesia, and in emergency situations. In this study we aimed at evaluating factors that could help in predicting the difficulty of bag-mask ventilation.

**Methods:** In a prospective study, 200 patients were allocated into two groups, 100 each. First group with a ULBT class I, and the other group with ULBT class II and III. Factors such as height, weight, gender, past history of snoring, neck circumference, Mallampati class, sternomental and thyromental distances were then evaluated in each of the patients in the two groups in order to arrive at their impact on the incidence of difficult mask ventilation.

Data were analyzed using Chi-square, student t-test and Fisher's exact tests depending upon the situation. A  $p < 0.05$  was considered to be statistically significant.

**Results:** The results revealed that negative predictive value (NPV) of ULBT class, history of snoring and neck circumference were 86%, 83%, 81%, respectively. A combination of these three predictors had an NPV of 95%.

**Conclusion:** ULBT class alone was of value in predicting difficulty in mask ventilation, but a combination of the three tests significantly improved the predictive value.

**Key Words:** Airway Management, Anesthesia Complications, Anesthesia Risk, Difficult Mask Ventilation, Upper Lip Bite Test.

## Introduction

The human airway and its assessment has been a subject that has been studied at length and discussed in innumerable publications. Despite the methods forwarded so far in anticipating difficulty in laryngoscopy and intubation, there still are cases where anticipation of the ease of laryngoscopy becomes difficult. Under such circumstances maintaining mask ventilation becomes life saving. If oxygenation cannot

be maintained via a bag-mask system, the patient's life may be threatened.

Difficult mask ventilation (DMV) has received less attention, which of course does not diminish its importance. Studies in the past have elaborately discussed the possible incriminating factors for DMV. Mallampati class 3 or 4, body mass index (BMI)  $> 25 \text{ kg/m}^2$ , old age, history of snoring and male gender have been declared independently as the possible causes of DMV<sup>1,2</sup>.

The aim of this study was to evaluate the diagnostic value of the upper lip bite test (ULBT) as a predictor of DMV and to also assess a combination of ULBT and other predictors in exploring the predictability of DMV before attempting induction of anesthesia.

## Methods and Materials

After an institutional approval and obtaining written informed consent, 200 patients (82 males, 118 females) undergoing surgery and requiring endotracheal intubation were enrolled in this study. Exclusion criteria included compromised critical airway, emergent cases, noncompliant patients and those with anatomical anomalies in the airway, pregnant, edentulous, those having beard and patients less than 14 years and those in whom a good mask fit was not possible.

According to the pilot study, with negative predictive value of 85% for ULBT,  $\alpha = 0.05$  and  $d = 7\%$ , the calculated sample size was at least 100 patients with ULBT class I. With low incidence of ULBT class III we decided to consider ULBT class II and III as a one group and a total of 100 patients were allocated into this group.

A questionnaire including demographic data [age, height, gender, weight, BMI, sex], past history of snoring, neck circumference, ULBT class, Mallampati classification, thyromental distance (TMD), and sternomental (SMD) for each patient was filled out by a 3rd year resident. The neck circumference was measured in cm by a measuring tape passing around the neck at the level of thyroid prominence.

ULBT was assessed and rated by the investigator as described by Khan et al<sup>3</sup>.

The Mallampati class was assessed as described by Samssoon and Young<sup>4</sup>. The observer noted the

pharyngeal structures in a seated patient protruding the tongue as far as possible.

The TMD was measured between the prominence of thyroid cartilage and the bony point of the chin with the head fully extended on the neck.

The SMD was measured as a straight distance from the upper border of the manubrium sterni to the mentum, with patient's head fully extended.

After application of routine monitoring, midazolam 1 mg and fentanyl (1 µg/kg) were administered intravenously, then an induction dose of thiopental 4 mg/kg was given followed by atracurium 0.5 mg/kg given IV to facilitate endotracheal intubation.

Before attempting laryngoscopy, patient was ventilated by mask by an anesthesiologist blinded to the study. Mask ventilation was performed by means of an appropriate sized face mask applied to the face and a reservoir bag receiving a continuous flow of oxygen from the anesthesia machine. Mask ventilation

was categorized Grade I as easy if the arterial oxygen saturation (SpO<sub>2</sub>) was >92% and chest expansion was visible. Grade II was categorized if additional measures such as an airway or O<sub>2</sub> flush was to be needed to maintain ventilation or else the assistance of another person was required. Grade III was categorized if despite the use of all the above measures, the SpO<sub>2</sub> failed to show a rise and endotracheal intubation thus attempted.

For statistical analysis, SPSS version 16 was used. Data were analyzed using Chi square, student T-test and Fisher's exact test depending upon the situation. Multiple logistic regressions were employed to evaluate any confounding variable. The P values were determined in all situations, and they were considered statistically significant at P<0.05.

## Results

A total of 200 patients in two groups were included in this study. 100 patients had ULBT class

*Table 1*  
*Comparison of patients according to difficulty of mask ventilation (MV)*

Factor	Easy MV	Difficult MV	P value
Height (cm)	162.8 ± 11.4	162.9 ± 7.7	0.085
Weight (kg)	70.4 ± 14	72.9 ± 11.1	0.42
BMI (kg/m <sup>2</sup> )	26.6 ± 4.9	27.6 ± 4.5	0.97
Age (year)	35.6 ± 11.9	40.8 ± 12.4	0.98
Gender			0.759
Female	84(0.42)	34(0.17)	
Male	60(0.30)	22(0.11)	
Mallampati class			0.671
1.	90(0.45)	34(0.17)	
2.	52(0.26)	22(0.11)	
3.	2(0.01)	0(0.00)	
4.	0(0.00)	0(0.00)	
Neck circumference (cm)	37.3 ± 4.5	39.4 ± 5	0.003
TMD (cm)	6.8 ± 1.4	6.9 ± 1.3	0.439
SMD (cm)	16.3 ± 2.6	16 ± 2.4	0.641
History of snoring			<0.001
No	94(0.47)	18(0.09)	
Yes	50(0.25)	38(0.19)	
ULBT			
1	86(0.43)	14(0.07)	<0.001
2 & 3	58(0.29)	42(0.21)	

*Table 2*  
*Diagnostic Value of the Number of Criteria in Predicting a Difficult Mask Ventilation (DMV)*

Criteria	Sensitivity (Se)	Specificity (Sp)	Positive Predictive Value (PPV)	Negative Predictive Value (NPV)
ULBT(1)	75%	59%	42%	86%
Snoring(2)	68%	65%	43%	83%
Neck Circumferences <sup>3</sup>	67%	54%	36%	81%
1+2	89%	44%	38%	81%
1+3	92%	31%	34%	92
2+3	89%	43%	37%	91%
1+2+3	96%	29%	34%	95%

1 and the rest had ULBT class 2 and 3. Difficult mask ventilation was found to occur in 56 (28%) patients (7% in ULBT class I and 21% in class II & III). In none of the patients a cannot ventilate, cannot intubate scenario was encountered. Demographic characteristics (height, weight, BMI, age and sex) of patients were recorded at the beginning of the examination. Mallampati class, ULBT, TMD, SMD, history of snoring, neck circumference were also obtained and recorded during the study (Table 1).

Diagnostic value of ULBT, snoring and neck circumference as predictive criteria of DMV were calculated individually, then a combination of the tests were paired together and analyzed and finally a combination of all the three criteria was collectively assessed to ascertain its value in the prediction of DMV (Table 2).

In the multivariate analysis, the criteria of ULBT, snoring and neck circumference which correlated with DMV in the univariate analysis, were again found to be significantly associated with DMV (Table 3).

## Discussion

Difficult mask ventilation may occur before attempting intubation, that is after induction of

anesthesia or it may occur after an unsuccessful attempt of intubation. Our study focuses on DMV in the first situation which has been grossly underestimated in the available literature.

Langeron et al<sup>2</sup> in their study reported an incidence of 5% of this situation, and stressed that this happening was relatively common. In our present study as one group of patients was selected with a ULBT class of II and III, this in itself resulted in a high incidence of DMV in this particular group (28%) and as such a higher prevalence of DMV compared to that found in the general population was obtained.

A good mask fit and proper ventilation is of an indispensable and pivotal value prior to endotracheal intubation. Preoperative assessment helps in overcoming any difficulty in mask ventilation and its attendant complications. Although securing the airway with an endotracheal tube is the ultimate and safest objective of an anesthesiologist to conduct safe anesthesia, nevertheless mask ventilation provides an opportunity to cater for patient till other options are implemented and a secure airway guaranteed<sup>5</sup>.

Several studies have been conducted to assess airway preoperatively<sup>3,4,6</sup>, and assessing the ease of

*Table 3*  
*Identification of Risk Factors for Difficult Mask Ventilation with Multivariate Analysis*

Variables	Odds ratio (CI)	P value
ULBT	3.76 (1.82 - 8.79)	<0.001
Snoring	2.56 (1.27 - 5.2)	<0.009
Neck circumference	2.1 (1.03 - 4.24)	<0.04

mask ventilation<sup>1,7,8,9</sup>. In these studies factors having an impact on mask ventilation such as SMD<sup>10</sup>, TMD<sup>8</sup>, Mallampati classification<sup>6</sup>, mouth opening<sup>11</sup>, mandible protrusion<sup>12</sup>, age, gender, height, BMI, weight<sup>7</sup>, dental morphology<sup>11</sup>, neck extension<sup>13</sup>, snoring<sup>8</sup> and the presence of beard<sup>2</sup>, were evaluated. These variables were considered both independently and in combination to predict the ease or else difficulty in mask ventilation. The ULBT classification forwarded by Khan et al (2003<sup>3</sup>) to predict the airway configuration and ease in laryngoscopy and intubation has not been tested to predict difficulty in mask ventilation. On the hypothesis that as both mandibular movement and buck teeth which the ULBT fully incorporates could serve in anticipating difficulty in mask ventilation, the present study was designed and conducted. This study revealed that ULBT correctly and accurately depicted the ease in mask ventilation, as signified by its high sensitivity and odds ratio, both highly significant. Since no such study has been conducted so far, we cannot corroborate it with another similar study. Again we found that the ULBT class 2 and 3, history of snoring and a large neck circumference positively correlated with and could predict difficulty in mask ventilation. This is the only study that has been conducted so far and we could find that a higher ULBT class had a direct impact on difficulty in mask ventilation. In this study for SMD<sup>10</sup>, TMD<sup>8</sup>, the measurements advocated so far were utilized, but for measuring the neck circumference, ROC was utilized to determine the best cut off point, which as measured at the level of the thyroid cartilage was 37 cm. According to findings obtained (Table 1), it can be inferred that SMD and TMD in two groups did not have a notable difference as regards the ease or difficulty in mask ventilation ( $P>0.05$ ). Although our goal was not to evaluate all the factors presumed to have an association or an impact on DMV, studies in the past have found gender, TMD and a Mallampati class to have an association with DMV<sup>8</sup>. Our objective was to find an explicit association between ULBT class and DMV. Perhaps a reason for the disparity of our findings in this study about these variables could be attributed to the small sample size in this survey.

It has been stated that tracheal intubation may be achieved easily in some of the patients in whom DMV is encountered. Thus, the most prudent step would be to attempt tracheal intubation as the first intervention if mask ventilation is unmanageable with application of any additional measures such as an oral airway, O<sub>2</sub> flush or help of two providers. In case, these measure fail, the alternative and plausible approach would be to use the laryngeal mask airway (LMA). Airway management was based on American Society of Anesthesiologists Task Force on Management of the Difficult Airway<sup>14</sup>. In our series of patients, we did not encounter a cannot ventilate-cannot intubate scenario, perhaps owing to small size of our patient population, its incidence is estimated to range between 0.01 and 2.0 per 10,000 patients<sup>15</sup>.

Although an ideal test is the one that has a high sensitivity, specificity and positive and negative predictive values, presently no such test exists. In order to circumvent the problems associated with DMV, it should be predicted in advance and ruled out as far as possible before initiating induction of anesthesia, thus any test that has a high NPV would be of greater help. As depicted (Table 2) the presence of ULBT class I or the absence of ULBT class II and III carries a Se of 75% and a NPV of 86% imparts an optimism for the anesthesiologist that DMV would not be difficult, but as stressed earlier optimism cannot be guaranteed fully to be easy.

Again when the other variables (neck circumference and past history of snoring) are taken concurrently into consideration, the combination further enhances the Se and the NPV to 96% and 95% respectively, providing us a promising clue that the DMV could easily be ruled out, and mask ventilation in a high percentage of patients with a high dependability would be easy.

In conclusion, it is suggested that a combination of ULBT, past history of snoring and neck circumference be utilized in the prediction of DMV as these composite variables yielded the best results.

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