A Comparison of the Upper Lip Bite Test (a Simple New Technique) with Modified Mallampati Classification in Predicting Difficulty in Endotracheal Intubation: A Prospective Blinded Study

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We explored the possibility that a simple and single test could replace the modified Mallampati score for either a difficult or an unaccomplished tracheal intubation in an impending hypoxic patient. Three hundred adult patients were enrolled in this study. They were subjected to the following assessments: 1) oropharyngeal class according to the modified Mallampati criteria; 2) the new, upper lip bite 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, and class III = lower incisors cannot bite the upper lip; and 3) laryngeal view grading according to Cormack's criteria. The incidence of difficult intubation was 5.7%. The upper lip bite test showed significantly higher specificity and accuracy than the modified Mallampati test ($P < 0.001$). Comparisons of sensitivity, positive and negative predictive values, between the two tests, however, did not reveal any significant differences ($P > 0.05$). In conclusion, the upper lip bite test is an acceptable option for predicting difficult intubation as a simple, single test.

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Unanticipated difficult laryngoscopic tracheal intubation remains a primary concern of anesthesiologists. The reported incidence of a difficult laryngoscopy or endotracheal intubation varies from 1.5% to 13% in patients undergoing surgery (1). Because of the potentially serious consequences of failed tracheal intubation, considerable attention has been focused on attempts to predict patients in whom laryngoscopy and intubation will be difficult (2).

Although many advances have been made and many time-tested methods have been used to overcome the conundrum of an unanticipated difficult laryngoscopic tracheal intubation, available tests, such as the Mallampati technique, interincisal gap, subluxation of the mandible, thyromental distance, length of mandibular rami, profile classification, chin protrusion, and atlanto-occipital extension (3) are not totally reliable. Because the range and freedom of mandibular movement and the architecture of the teeth have pivotal roles in facilitating laryngoscopic intubation, we hypothesized that the upper lip bite test (ULBT) could serve as a good predictor for difficult laryngoscopic intubation. To test the validity of this hypothesis, we conducted a study in patients undergoing general anesthesia.

Methods

Approval for the study was obtained from our institution's human subjects committee, and informed consent was obtained from the patients. Consecutive male and female patients, aged ≥16 yr, scheduled to undergo surgery under general anesthesia between January 2001 and November 2001, were considered for enrollment. Edentulous patients, those unable to open the mouth, with laryngeal masses, or with limitation of cervical movements were excluded from the study.

Preoperatively, two anesthesiologists not involved in intubating the airways of the patients they evaluated obtained measurements by using the modified Mallampati test (MMT) or the ULBT. 1) Classification of the oropharyngeal view was done according to the MMT: class I = soft palate, fauces, uvula, and pillars seen; class II = soft palate, fauces, and uvula seen; class III = soft palate and base of uvula seen; and class

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IV = soft palate not visible. The examination to determine oropharyngeal class was done with the aid of a flashlight. The patients were in a sitting position with the tongue fully protruding; they were not asked to say "ah" (4–6). 2) The new ULBT, introduced by the first principal author (ZHK), was performed according to the following criteria: class I = lower incisors can bite the upper lip above the vermilion line (Figs. 1A and 2A); class II = lower incisors can bite the upper lip below the vermilion line (Figs. 1B and 2B); and class III = lower incisors cannot bite the upper lip (Figs. 1C and 2C).

Anesthesiologists, who were not informed of the preoperative modified Mallampati and upper lip bite classes, assessed difficulty of laryngoscopy at intubation, which was performed with the patient adequately anesthetized and fully relaxed on the operating room table. The head was placed in the sniffing position, and initial laryngoscopy was performed with a Macintosh No. 3 blade (Welch Allyn Inc., Skaneatills Falls, NY). However, if difficulty was encountered and the first attempt failed to provide a laryngoscopic view, a Miller laryngoscope blade (Welch Allyn) was used coupled with external laryngeal pressure and adjustment of head position as the situation demanded.

The laryngeal view was graded according to the method described by Cormack and Lehane (7) as grade I (full view of the glottis), grade II (glottis partly exposed, anterior commissure not seen), grade III (only epiglottis seen), or grade IV (epiglottis not seen); no external laryngeal pressure was applied while reporting the laryngeal view. A grade of I or II was considered to represent easy intubation and a grade of III or IV to represent difficult intubation.

The preoperative assessment data and the intubation findings were used to determine the accuracy of the above mentioned tests in predicting difficult intubation. Sensitivity, specificity, accuracy, and positive and negative predictive values were calculated for each test. (The definitions of the aforementioned statistical terms have been provided in Appendix 1.)

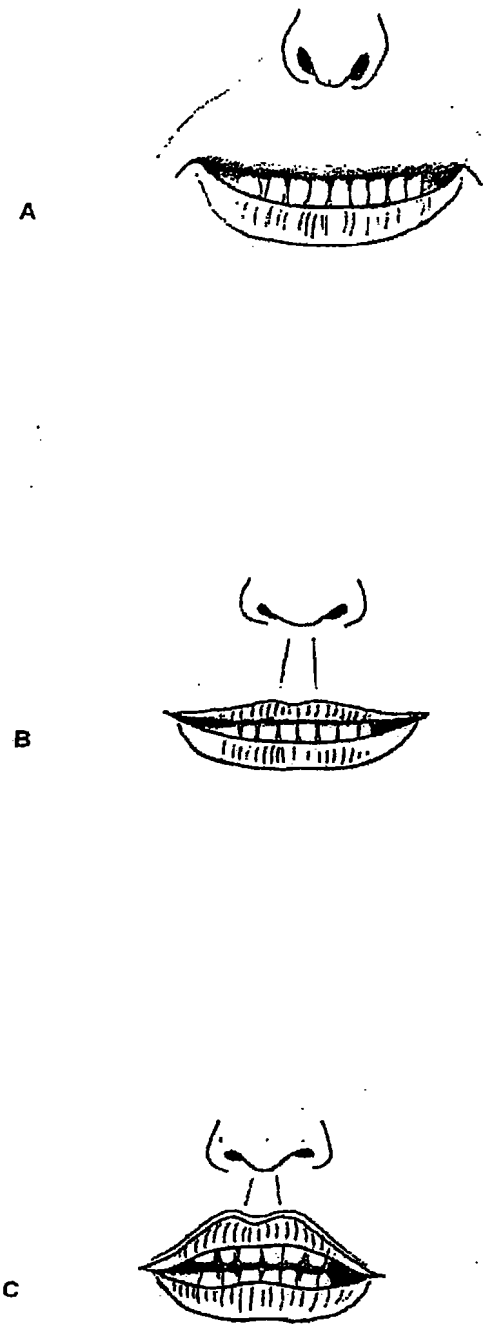

Figure 1. Schematic frontal view of the upper lip bite test. A, Class I; lower incisors biting the upper lip, making the mucosa of the upper lip totally invisible. B, Class II; the same biting maneuver revealing a partially visible mucosa. C, Class III; the lower incisors fail to bite the upper lip.

Results

Three hundred patients were enrolled in the study. Seventeen of them were found at laryngoscopy to have airways that were difficult to intubate, exhibiting laryngoscopy grade III or IV. There were no failed intubations. Assignment to modified Mallampati class III or IV and upper lip bite class III were selected as indicators of difficult intubation.

In this prospective, blinded study, we found that 192 patients had modified Mallampati class I or II and 108 patients had class III or IV, whereas 255 patients were assessed to have upper lip bite class I or II and 45 patients class III (Table 1). True positive, false positive, true negative, and false negative results together with sensitivity, specificity, positive predictive value, negative predictive value, and accuracy for MMT and ULBT are shown in Table 2.

Using the McNemar test, statistically significant differences were observed between the specificity and accuracy of the two previously mentioned tests ($P < 0.001$), showing higher levels for ULBT. Comparisons

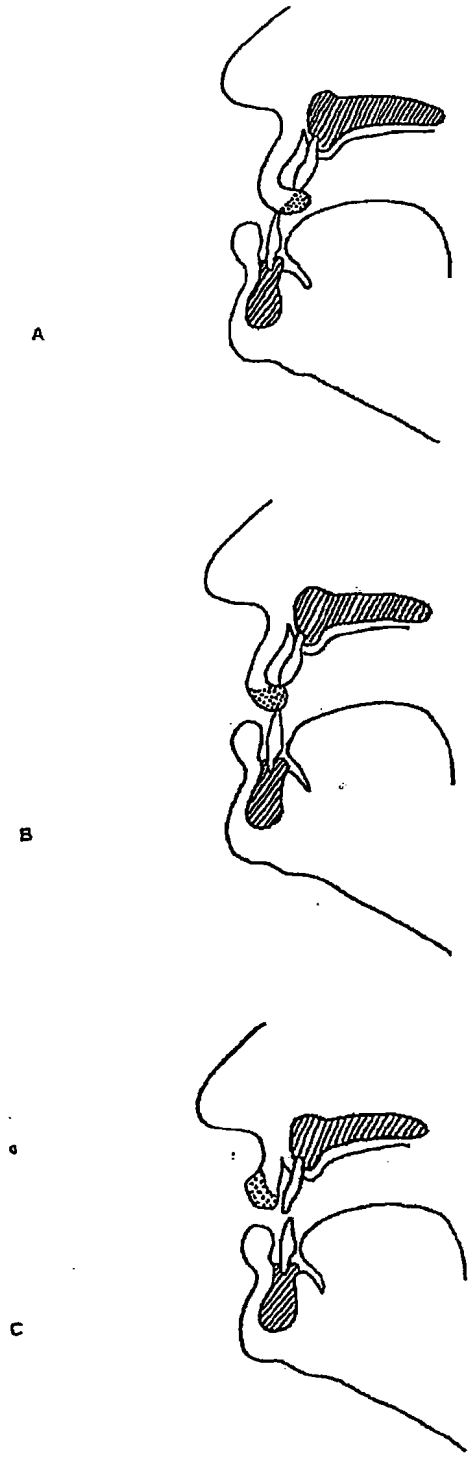

Figure 2. Schematic lateral view of the upper lip bite test. The dotted area depicts the mucosa of the upper lip. A, Class I; lower incisors reflecting a bite of the upper lip, making its mucosa entirely invisible. B, Class II; lower incisors half-biting the upper lip, making the mucosa partially visible. C, Class III; lower incisors attempting a bite but totally failing to catch the upper lip.

of sensitivity findings using Fisher's exact test and the McNemar test for positive predictive values and negative predictive values between MMT and ULBT did not depict any significant differences ($P > 0.05$).

Table 1. Relationship Between the Results of Two Predicting Tests and Laryngoscopy Grades in 300 Patients

Predicting test	Laryngoscopic view	
	I and II	III and IV
Modified Mallampati		
Classes I and II	189	3
Classes III and IV	94	14
Upper lip bite		
Classes I and II	251	4
Class III	32	13

Discussion

The failure of the anesthesiologist to maintain a patent airway after the induction of general anesthesia is one of the most common causes of anesthesia-related morbidity and mortality (3,8,9).

The incidence of difficult intubation is 1.3%, 1.5%, 1.8%, 3.5%, 4%, 4.5%, 4.9%, 7%, 8%, and 13% (2,5,8,10–16), depending on the criteria used to define it. The incidence of failure to intubate the trachea is 0.05%–0.35% (16). We found a 5.7% incidence of difficult intubation in this study and there were no failures to intubate the trachea. Although some authors blame different anthropomorphic features among populations as the cause of the discrepancies in the incidence of difficult intubation in different studies, such differences may be attributed to the fact that sometimes the cases in which pressure was applied to the larynx were excluded from the "difficult intubation" group (15).

Wilson et al. (8) described five risk factors that are important in predicting difficult intubation, including weight ($P = 0.05$), head and neck movement ($P = 0.001$), jaw movement ($P = 0.001$), receding mandible ($P = 0.001$), and buck teeth ($P = 0.001$). Our technique, the ULBT, assesses a combination of jaw subluxation and the presence of buck teeth simultaneously, obviously enhancing its predictive value and reliability.

We found the specificity and accuracy of the ULBT to be better than the MMT, but the sensitivity, positive predictive value, and negative predictive value of both tests were similar. Specificity of the ULBT was 88.7%, whereas this variable for the MMT was 66.8%. Savva (13) reported the same specificity for MMT, although larger percentages (82%, 84%) have been reported in other studies (9,12). The difference between the reported specificity results suggests an incorrect evaluation; moreover, many patients involuntarily phonate during the test, which may significantly alter the Mallampati classification (15).

The sensitivity of MMT in our study was 82.4%, which is appealing, but its accompanying large false positive values (33.2%) could result in extra time to

Table 2. Statistical Terms Used for Modified Mallampati and Upper Lip Bite as Predicting Tests

Test	TP	FP	TN	FN	Acc % (95% CI)	Se % (95% CI)	Sp % (95% CI)	PPV % (95% CI)	NPV % (95% CI)
Modified Mallampati	14	94	189	3	67.7 (62–72.9)	82.4 (55.8–95.3)	66.8 (60.9–72.2)	13 (7.5–21.1)	98.4 (95.1–99.6)
Upper lip bite	13	32	251	4	88 (79.9–93.6)	76.5 (49.8–92.2)	88.7 (84.3–92)	28.9 (16.8–44.5)	98.4 (95.8–99.5)

TP = true positive; FP = false positive; TN = true negative; FN = false negative; Acc = accuracy or total correct prediction; Se = sensitivity; Sp = specificity; PPV = positive predictive value; NPV = negative predictive value; CI = confidence interval.

overcome difficulties of anticipated difficult intubation by provision of alternative measures such as fiberoptic intubation, cricothyroidotomy, transtracheal jet ventilation, and/or awake trials of intubation.

The three classes for the new test (ULBT) are clearly demarcated and delineated, making interobserver variations highly unlikely when using this test (in contrast to considerable interobserver variations found with the MMT which has been controversial) (9,17). MMT in assessing oropharyngeal view has had poor reliability (3), which could be attributed to the technicalities involved in the demonstration, and discrepancies in evaluating and interpreting the observations. On the contrary, the ULBT and its practical interpretations for predicting a difficult airway can be quickly understood. We believe that a precise, tangible, and practically workable test would decrease differences between various examiners' observations.

The possible limitation of this study, and any clinical or bedside study, is that patients do not completely understand the instructions. We suggest that the anesthesiologist demonstrate the test, thereby enabling patient compliance.

In conclusion, the ULBT has an inherently larger level of accuracy compared with the MMT. The ULBT could easily predict 76.5% of difficult intubations and, similarly, could predict 88.7% of easy intubations. Moreover, 98.4% of the intubations declared as easy were, in fact, found to be easy, whereas 28.9% of the intubations predicted to be difficult were, in fact, difficult while attempting laryngoscopic intubation. In general, 88% of easy and difficult intubations were correctly predicted. In this study, we compared ULBT with the MMT but suggest that it be compared with the other prevailing tests as well which are often used to assess difficult intubations.

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Appendix 1: Statistical Terms (16)

True positive = a difficult intubation that had been predicted to be difficult

False positive = an easy intubation that had been predicted to be difficult

True negative = an easy intubation that had been predicted to be easy

False negative = a difficult intubation that had been predicted to be easy

Sensitivity = the percentage of correctly predicted difficult intubations as a proportion of all intubations that were truly difficult, i.e., true positives/(true positives + false negatives)

Specificity = the percentage of correctly predicted easy intubations as a proportion of all intubations that were truly easy, i.e., true negatives/(true negatives + false positives)

Positive predictive value = the percentage of correctly predicted difficult intubations as a proportion of all predicted difficult intubations, i.e., true positives/(true positives + false positives)

Negative predictive value = the percentage of correctly predicted easy intubations as a proportion of all predicted easy intubations, i.e., true negatives/(true negatives + false negatives)

Accuracy = the percentage of correctly predicted easy or difficult intubations as a proportion of all intubations, i.e., (true positives + true negatives)/(true positives + true negatives + false positives + false negatives).

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