The Diagnostic Value of the Upper Lip Bite Test Combined with Sternomental Distance, Thyromental Distance, and Interincisor Distance for Prediction of Easy Laryngoscopy and Intubation: A Prospective Study

Zahid Hussain Khan, MD*

Mostafa Mohammadi, MD*

Mohammad R. Rasouli, MD†

Fahimeh Farrokhnia, MD*

Razmeh Hussain Khan‡

BACKGROUND: Accuracy of upper lip bite test (ULBT) has been compared with the Mallampati classification. In this study, we investigated whether the combination of the ULBT classification with sternomental distance (SMD), thyromental distance (TMD), and interincisor distance (IID) or a composite score can improve the ability to predict easy laryngoscopy and intubation compared with each test alone.

METHODS: In a prospective study, 380 patients who were scheduled for elective surgery were selected randomly and enrolled in the study. Before inducing anesthesia, the airways were assessed, and ULBT class, SMD, TMD, and IID determined. Laryngoscopic view according to the Cormack and Lehane grading system was determined after induction of anesthesia and Grades 3 and 4 defined as "difficult intubation." By using receiver operating characteristic analysis, the best cutoff points of the tests were calculated. Finally, sensitivity, specificity, positive and negative predictive values and accuracy of these tests and their combinations with the ULBT were calculated.

RESULTS: The prevalence of difficult intubation was 5% ($n = 19$). Class III ULBT, IID <4.5 cm, TMD <6.5 cm, and SMD <13 cm were defined as predictors of difficult intubation. There was no significant difference regarding difficult intubation based on gender ($P < 0.05$), whereas there were significant differences between the older tests and laryngeal view ($P < 0.05$, Mc-Nemar test). Specificity and accuracy of the ULBT were significantly higher than TMD, SMD, and IID individually (specificity was 91.69%, 82.27%, 70.64%, and 82.27%, respectively, and accuracy was 91.05%, 71.32%, 81.84%, and 76.58%, respectively). The combination of the ULBT with SMD provided the highest sensitivity.

CONCLUSION: We conclude that the specificity and accuracy of the ULBT is significantly higher than the other tests and is more accurate in airway assessment. However, the ULBT in conjunction with the other tests could more reliably predict easy laryngoscopy or intubation.

(Anesth Analg 2009;109:822–4)

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, most tests are not reliable.[1] All preoperative airway assessment tests are characterized by low sensitivity, reasonable specificity, low positive predictive value (PPV), and significant false positives.[2–4]

Although our initial evaluation of the upper lip bite test (ULBT[1]) showed greater specificity and accuracy compared with the Mallampati classification, the ULBT has not been compared with other tests, such as measurement of sternomental distance (SMD), thyromental distance (TMD), and interincisor distance (IID). In this study, the ULBT is compared with these tests for preoperative assessment of airway and prediction of ease of tracheal intubation. We also aim to describe a composite measure that combines ULBT with each of the other measures.

METHODS

Three hundred eighty ASA I patients older than 16 yr scheduled for elective surgical procedures requiring endotracheal intubation were enrolled in the study after approval of the ethics committee of the university. Verbal informed consent was obtained from each patient before starting the study. Patients with any airway abnormality or obvious neck pathology were excluded.

The SMD was measured in supine position with the head fully extended and with the mouth closed. The straight distance between the upper border of the manubrium sterni and the bony point of the mentum was measured. For TMD, the straight distance between the upper border of the thyroid cartilage and the bony point of mentum was measured.[5] IID was measured when the patient opened his or her mouth, and the distance between incisors was obtained. The ULBT class was determined 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; and Class III, lower incisors cannot bite the upper lip.[1]

Anesthesia was induced with midazolam (1 mg), fentanyl (2 μg/kg), thiopental (5 mg/kg), and atracurium (0.5 mg/kg). With the head in the sniffing position, laryngoscopy with a Macintosh 3 blade was attempted, and the view determined using the Cormack-Lehane (C-L) grading system.[6] C-L Grades 1 and 2 were categorized as "easy intubations" and Grades 3 and 4 as "difficult intubations." All preoperative airway assessments and measurements were performed by a third-year resident, and subsequent laryngoscopies and C-L grading were conducted and scored by one of the authors (ZHK), who was blinded to the observations made preoperatively.

Statistical analysis was performed using SPSS software version 10.5 (SPSS, Chicago, IL) and MedCalc version 9.2 (MedCalc Software, Maria-kerke, Belgium). Receiver operating characteristic (ROC) analysis was used to determine the accuracy of each test and the combination of ULBT with the other tests (SMD, TMD, and IID). For this purpose, a binary variable was defined. If both the ULBT and the other test had predicted easy intubation based on obtained cutoff points, the new variable was coded as "easy." If one or both of them had predicted difficult intubation, the variable value was coded as "difficult intubation." Sensitivity, specificity, accuracy, PPV, and negative predictive values (NPV) were then calculated. The best cutoff points were determined by selecting a point where the sensitivity and specificity were approximately equal. Data were analyzed by using Fisher's exact and Mc-Nemar tests, and a P value <0.05 was considered statistically significant.

RESULTS

Three hundred nine patients (209 men) were included in the study. The mean age was 34 $\pm$ 10 yr (mean $\pm$ sd). Intubation was difficult in 19 patients (5%, C-L Grades of 3 and 4 in 17 and two cases, respectively). The ULBT classes versus C-L grades are depicted in Figure 1.

By using receiver operating characteristic analysis, Class III ULBT, IID $\leq$4.5 cm, TMD $\leq$6.5 cm, and SMD $\leq$13 cm were defined as cutoff points for difficult intubation (Table 1). These criteria were determined to predict difficult intubation.
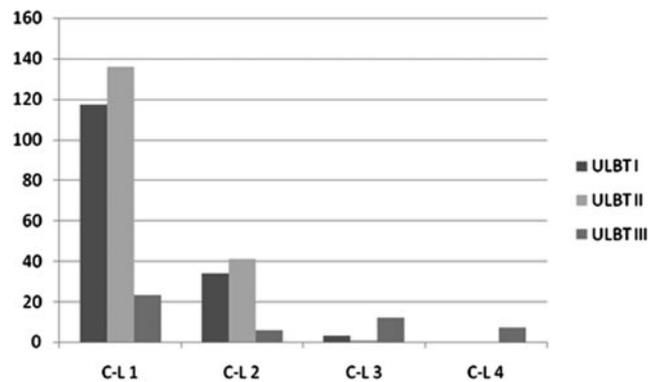

Figure 1. The upper lip bite test (ULBT) classes versus Cormack-Lehane (C-L) grading.

There was no significant difference regarding difficult intubation according to gender ($P > 0.05$, χ^2 test). However, there were differences by gender with regard to the tests and C-L grades ($P < 0.05$, Mc-Nemar test). A combination of each test with the ULBT showed the highest sensitivity for the combination of ULBT with SMD, whereas the highest specificity was found in the combination of ULBT with TMD.

DISCUSSION

Our results show that the ULBT has higher accuracy and specificity than the other tests and also a high NPV. The results also indicate that Class I ULBT is more likely to predict an easy intubation than the other tests. We further found that the combination of SMD and ULBT improved the sensitivity of ULBT when compared with the latter alone. This finding was the hallmark of our results when the tests were combined. However, the combination of the ULBT with the other tests did not show any superiority to the ULBT alone with regard to specificity. A combination of these tests did not enhance PPV, NPV, and accuracy compared with those obtained with the ULBT alone.

One of the most important challenges in using SMD, TMD, and IID is the quantitative nature of these tests,[7,8] whereas the classification of patients based on the ULBT is of a qualitative nature, making differentiation of classes easy and precise. In brief, the differences between the ULBT and the other tests are those between continuous and discrete variables. Thus, the ULBT is associated with the least interobserver variability, which adds to its advantage as an airway assessment test. These findings are consistent with a previous report by Eberhart et al.,[9] which showed that the interobserver reliability of the ULBT is higher than the Mallampati classification.

The prevalence of difficult intubation in our study was 5%; however, failure to intubate was not encountered. Our results corroborate those of a previous study, which reported a prevalence of 4.7% for difficult intubation.[3] Wilson et al.[10] suggested five risk factors in predicting difficult intubation, including

Table 1. Area Under the ROC Curve, Sensitivity, Specificity, Positive and Negative Predictive Values, and Accuracy of Interincisor Distance (IID), Thyromental Distance (TMD), Sternomental Distance (SMD), and Upper Lip Bite Test (ULBT) Are Being Shown

	Area under the ROC curve	Sensitivity	Specificity	Positive predictive value	Negative predictive value	Accuracy
IID ≤4.5 cm	0.72 (0.6–0.85)	68.4 (46.7–84.4)	77.0 (75.9–77.9)*	13.5 (9.3–16.7)	97.8 (96.4–99)	76.5 (74.2–78.2)*
TMD ≤6.5 cm	0.78 (0.66–0.89)	73.6 (52.1–88)	82.2 (81.1–83)*	17.9 (12.7–21.4)	98.3 (97–99.2)	81.8 (79.7–83.3)*
SMD ≤13.5 cm	0.77 (0.67–0.87)	84.2 (63.1–94.4)	70.6 (69.5–71.2)*	13.1 (9.8–14.7)*	98.8 (97.3–99.6)	71.3 (69.2–72.3)*
ULBT class III	0.85 (0.74–0.96)	78.9 (58.3–91.3)	91.9 (90.9–92.6)	33.3 (25.2–39.4)	98.8 (97.6–99.5)	91.0 (89.3–92.5)
IID + ULBT	0.77 (0.73–0.81)	78.9 (57.4–91.4)	76.2 (75–76.8)	14.9 (10.8–17.2)	98.6 (97.1–99.4)	76.3 (74.2–77.6)
TMD + ULBT	0.79 (0.74–0.83)	78.9 (57.5–91.4)	79.8 (78.8–80.4)	17.0 (12.4–19.7)	98.6 (97.2–99.4)	79.7 (77.6–81)
SMD + ULBT	0.76 (71–80)	84.2 (63.1–94.4)	67.9 (66.8–68.4)	12.1 (9.1–13.6)	98.8 (97.2–99.6)	68.7 (66.6–69.7)

Negative predictive value for all tests is high, indicating that all tests can predict easy intubation readily.

ROC = Receiver operating characteristic.

* Significant differences with the similar parameter in ULBT ($P < 0.05$, Fisher's exact test).

weight ($P = 0.05$), head and neck movement ($P = 0.001$), jaw movement ($P = 0.001$), receding mandible ($P = 0.001$), and protruding ("buck") upper incisors ($P = 0.001$). The ULBT when tested initially had the potential to evaluate both jaw movement and buck teeth simultaneously, providing additional support for its use as an airway assessment test.

Sensitivity, specificity, and accuracy of the ULBT (78.95%, 91.96%, and 91.05%, respectively) were similar to those reported in the earlier study (76.5%, 88.7%, and 88%, respectively).[1]

The ULBT has high specificity and NPV, making it superior in identifying easy tracheal intubation and laryngoscopy. The sensitivity and specificity of SMD and TMD corroborate previous data.[2] With regard to the combination of ULBT and other tests, we found that the combination of the SMD and the ULBT had a higher sensitivity than the ULBT alone; however, this combination had lower specificity and PPV than the ULBT alone.

Our results differ from those of Richa et al.,[11] which showed a low sensitivity for the combination of the ULBT with the TMD and ULBT with SMD (18.7% and 15.6%, respectively) but high specificity for these combinations (99% and 98%, respectively). The PPV of the test combinations were 60% and 50%, respectively, whereas in our study, these combinations had lower PPV.[11] Because the predictive values depend on the values of sensitivity, specificity, and prevalence (which was higher in their study), this could explain the difference between our results and theirs.

A test to predict difficult intubation should have high sensitivity, so that it will identify most patients in whom intubation will truly be difficult.[7] It should also have a high PPV, so that only few patients with airways actually easy to intubate are subjected to the protocol for management of a difficult airway.[12,13] Similarly, a test should have a high NPV to correctly predict the ease of laryngoscopy and intubation. It is being argued that both long and short TMD portend difficulty in correctly anticipating the laryngeal view,[14] which challenges the validity of TMD as a useful screening test. On the other hand, the ULBT has the ability to assess jaw movement and protruding incisors simultaneously, enhancing its predictability. In conclusion, despite the fact that this study showed acceptable sensitivity and PPV of ULBT in comparison with the other tests, the ULBT is a test with

high specificity and NPV, making it a favorable test for identifying easy intubations and laryngoscopy. These findings are in agreement with those of Eberhart et al.[9] However, we suggest applying a combination of assessment methods in predicting the ease of intubation. Such a combination is preferable because anatomic predictors of difficult intubation carry a low-sensitivity rate when used alone, whereas a multivariate composite risk index may achieve better results than single, independent criteria.

REFERENCES

1. Khan ZH, Kashfi A, Ebrahimkhani E. 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. Anesth Analg 2003;96:595–9
2. Savva D. Prediction of difficult tracheal intubation. Br J Anaesth 1994;73:149–53
3. Rose DK, Cohen MM. The airway: problems and predictions in 18,500 patients. Can J Anaesth 1994;41:372–83
4. Samsoon GL, Young JR. Difficult tracheal intubation: a retrospective study. Anaesthesia 1987;42:487–90
5. Karkouti K, Rose DK, Wigglesworth D, Cohen MM. Predicting difficult intubation: a multivariable analysis. Can J Anaesth 2000;47:730–9
6. Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. Anaesthesia 1984;39:1105–11
7. Arne J, Descoins P, Fusciardi J, Ingrand P, Ferrier B, Boudigues D, Aries J. Preoperative assessment for difficult intubation in general and ENT surgery: predictive value of a clinical multivariate risk index. Br J Anaesth 1998;80:140–6
8. Karkouti K, Rose DK, Ferris LE, Wigglesworth DF, Meisami-Fard T, Lee H. Inter-observer reliability of ten tests used for predicting difficult tracheal intubation. Can J Anaesth 1996; 43:554–9
9. Eberhart LH, Arndt C, Cierpka T, Schwanekamp J, Wulf H, Putzke C. The reliability and validity of the upper lip bite test compared with the Mallampati classification to predict difficult laryngoscopy: an external prospective evaluation. Anesth Analg 2005;101:284–9
10. Wilson ME, Spiegelhalter D, Robertson JA, Lesser P. Predicting difficult intubation. Br J Anaesth 1988;61:211–6
11. Richa F, Yazbeck P, Yazigi A, Karim N, Antakly MC. Value of the association of the upper lip bite test (ULBT) with other tests in predicting difficulty of endotracheal intubation. Anesthesiology 2005:A1418 [abstract]
12. Tse JC, Rimm EB, Hussain A. Predicting difficult endotracheal intubation in surgical patients scheduled for general anesthesia: a prospective blind study. Anesth Analg 1995;81:254–8
13. Merah NA, Wong DT, Foulkes-Crabbe DJ, Kushimo OT, Bode CO. Modified Mallampati test, thyromental distance and interincisor gap are the best predictors of difficult laryngoscopy in West Africans. Can J Anaesth 2005;52:291–6
14. Brodsky JB, Lemmens HJ, Brock-Utne JG, Vierra M, Saidman LJ. Morbid obesity and tracheal intubation. Anesth Analg 2002; 94:732–6