The Mallampati Test versus the Upper Lip Bite Test in Predicting Difficult Intubation

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Introduction

The accurate assessment of the airway is one of the most important skills an anesthesia practitioner should perfect. A difficult intubation is often defined as a Cormack Lehane (CL) grade of III or IV in adult patients. The reported frequency of difficult intubation or CL grade III and IV is 12.35% and 9% in those undergoing a general anesthetic.[1] Several assessments and scoring systems are used by anesthesia providers with the goal of identifying a potentially difficult intubation.

The modified Mallampati test (MMT) is the most widely used tool for the assessment and prediction of the difficult intubation.[2] The oropharyngeal structures as well as space in the mouth are assessed and graded based on the view with the mouth opened maximally. A wide variability in the predictive value of the MMT in identifying a difficult intubation has been found.[1]

The upper lip bite test (ULBT) is a simple maneuver that may be used as an alternative for predicting difficult intubation. The patients' ability to extend their temporomandibular joint is measured by comparing the position of the lower incisors and upper lip.[2] The grades of the ULBT are easily identifiable and distinguishable from one another.

Reliable preoperative airway assessments are necessary to identify patients at risk of difficult or failed intubation. Failure to anticipate a difficult intubation can have serious consequences. The purpose of this evidence-based practice analysis is to compare the accuracy of the MMT with the ULBT in predicting difficult intubations in adult surgical patients undergoing general endotracheal anesthesia.

Methodology

The clinical question was expressed through the use of a PICO format. In adult patients undergoing general endotracheal anesthesia (P), does the ULBT (I) compared to the MMT (C), more accurately predict a CL grade III or IV(O)?

An electronic database search was conducted using EBSCO, PubMed, Google Scholar, Cochrane Database, and Cumulative Index to Nursing & Allied Health Literature (CINAHL). Peer-reviewed journals published in English between 2010 and 2017 were searched. Search Terms included: Airway assessment, Mallampati test, upper lip bite test, difficult intubation, difficult laryngoscopy, difficult endotracheal intubation, and difficult airway. All studies reviewed included adult patients undergoing general endotracheal anesthesia, with ages greater than 18 years.

Fifteen studies met the inclusion criteria with six studies excluded from analysis because the ULBT and MMT were not compared. One study that examined the obstetric population was also excluded. The eight remaining studies consisted of male and female adult patients that were 18 years of age or older. All included studies had an observational prospective design and were level III evidence in the Joanna Bringgs Institute hierarchy of evidence. The study participants had an American Society of Anesthesiologists (ASA) Physical Status classification of either I and II or I, II and III.

Literature Review

All studies used the CL classification for defining the ease of intubation. A CL grade I was defined as a full view of the glottis, a grade II was a partial view of the glottis, grade III was assigned when only the epiglottis was visible, and grade IV was assigned when the epiglottis was not visible. A CL grade I or II was considered easy, and a CL grade of III or IV was considered a difficult intubation in all studies.

The MMT in all studies was assessed with the patient in the sitting position, mouth wide open with the tongue fully protruded and without phonation. The patient was assigned a MMT class I if the pillars, uvula, soft palate, and hard palate could be seen; class II if all but the pillars could be seen; class III if the soft palate and hard palate only could be seen; and class IV if the only the hard palate was seen. The ULBT was done by asking patients to bite their upper lip with the lower incisors as high as possible in the sitting position with the head in neutral position. The ULBT was rated as class I if the lower incisors could bite the upper lip above the vermilion line, class II if the lower incisors could bite the upper lip below the vermilion line, and class III if the lower incisors could not bite the upper lip.

All of the studies rated a MMT score of I or II as a potentially easy intubation and a MMT score of III or IV as a potentially difficult intubation. Six of the eight studies rated an ULBT score of I or II as a potentially easy intubation and an ULBT score of III as a potentially difficult intubation. Honarmand et al[3] and Haq and Ullahl[2] determined that an ULBT score of I was considered a potentially easy intubation and a score of II or III was a potentially difficult intubation. Both the ULBT and MMT were obtained simultaneously by a single trained observer not involved in the clinical care. The results of the evaluations were not available to the provider performing the tracheal intubation.

All study subjects were scheduled for a general endotracheal anesthetic for an elective procedure and had routine monitors applied upon arrival to the operating room. The patient was then placed in a sniffing position and was asked to breathe 100% oxygen. An induction dose of anesthesia medications was given intravenously as well as a muscle relaxant. After full muscle paralysis of the patient, intubation was performed without applying external laryngeal pressure. Those performing the intubation had at least one year or more experience and were blinded to the results of the ULBT and MMT. All intubations were performed with a Macintosh laryngoscope blade size III or IV. A CL grade was then recorded for the patient.

Ali et al[3] evaluated 324 adult patients in a prospective cross-sectional study. Excluded patients were those not able to perform either of the tests, edentulous patients, or those requiring a rapid sequence induction. No patients were rated a CL grade IV upon intubation while 56 patients

(17.3%) were rated a CL grade III and a difficult intubation. Eleven (19.6%) of the 56 difficult intubations were rated a MMT grade III or IV compared to 49 (87.5%) rated an ULBT grade III.[4] The sensitivity, or the percentage of difficult intubations which were correctly predicted to be difficult intubations, was 87.5% with the ULBT and 19.6% with the MMT. Specificity, or the percentage of correctly predicted easy intubations as a proportion of all predicted easy intubations, was 92.9% for the ULBT and was very similar to the MMT specificity of 91.8%. The positive predictive value (PPV), or the number of predicted difficult intubations which were difficult, was 71.6% with the ULBT and 33.3% with the MMT. The negative predictive value (NPV), or the number of predicted easy intubations which were easy, was 97.3% for the ULBT and 84.8% for the MMT. The ULBT had a significantly higher sensitivity (p<0.05) compared to the MMT, and specificity was high for both the MMT and ULBT.

In a single-blinded prospective observational study Badheka et al[4] evaluated 170 adult patients. Excluded patients were those with head or neck abnormalities, who were edentulous, or who were scheduled for a cesarean section. Three had a CL grade IV and 48 had a CL grade III for a total of 51 (30%) difficult intubations. The sensitivity of the ULBT was 96.64% compared to 78.99% for the MMT. Specificity for the ULBT was 82.65% compared to 68.63% for the MMT. The ULBT PPV was 92.7% and the MMT PPV was 85.45% while the NPV for the ULBT was 91.3% and the MMT was 58.3%.[5] Sensitivity and specificity were both higher with the ULBT when compared to the MMT.

A prospective double-blinded study of 402 adult surgical patients was conducted by Wajekar et al.[5] Excluded patients were those with previous surgery, burns, tumors/masses in the head or neck region, patients with restricted neck mobility, edentulous patients, pregnant patients, and those with a BMI>26kg/m2. Forty-six (11.4%) patients were a difficult intubation with a CL of III or IV. The sensitivity of the ULBT was 98.6% compared to 90.4% for the MMT. Specificity for the ULBT was 8.7% compared to 30.4% for the MMT. The ULBT PPV was 89.3% and the MMT PPV was 91%. The NPV for the ULBT was 44.4% and the MMT was 29.2%.[6] A high sensitivity of the ULBT demonstrates that when it predicted a difficult intubation a high percentage were difficult, however, both the ULBT and MMT were highly sensitive in the study. The ULBT had a much lower specificity (8.7%) meaning many predicted easy intubations were difficult. The MMT also had a low (30.4%) specificity in the study.

Honarmand et al[6] conducted a prospective observational study of 525 adult patients. Excluded patients were those with previous surgery, burns, tumors/masses in the head or neck region, patients with restricted neck mobility, edentulous patients, those unable to sit, and those that required an awake intubation.[3] An ULBT of I was considered to predict an easy intubation, and a ULBT of II-III was considered to predicted a difficult intubation. The incidence of difficult intubation was found to be 9.7% or 51 patients. The ULBT sensitivity was 90.2% compared to the MMT of 68.6%. The specificity for the ULBT was 59.4% and 52.8% for the MMT. The ULBT PPV was 19.3%, and the MMT PPV was 13.6%. The low PPVs indicate that many predicted difficult intubations were easy. The NPV for the ULBT was 98.3% compared to the MMT NPV of 94.0%.

Another prospective observational study by Safavi et al[7] evaluated 467 adult patients. Excluded patients were those not able to cooperate, those with a burn or trauma to the airway, a tumor or

mass in the head or neck region, restricted mobility of the neck or mandible, and morbidly obese patients.[7] The incidence of difficult intubation was 6.9% with 25 patients with a CL grade III (5.3%), and 8 patients with a CL grade IV (1.8%). The ULBT sensitivity was 75.7% and the MMT was 63.6%. The ULBT specificity was 80.8% compared to the MMT of 46.95%. The ULBT PPV was 22.7% and MMT was 8.2%. The ULBT NPP was 97.8% and a MMT NPV of 94.5%. The sensitivity of the ULBT was higher than the MMT while both had a low PPV.

A prospective observational design was also used by Safavi et al[8] in evaluating 603 patients. Excluded patients were those with previous surgery, burns, tumors/masses in the head or neck region, patients with restricted neck mobility, edentulous patients, those unable to sit, and those that required an awake intubation.[8] There were 41 (6.8%) patients with a CL grade of III or IV, or a difficult intubation. Sensitivity of the ULBT was 66.01% compared to 87.37% for the MMT. Specificity of the UBLT was 73.1% compared to 14.63% for the MMT. The PPV of the ULBT was 97.1% compared to 93.3% for the MMT. The ULBT NPV was 13.6% compared to a 7.8% NPV for the MMT. The area under the curve (AUC) for the ULBT was 0.82, significantly greater (p<0.0001) compared to the MMT AUC of 0.56. Although the sensitivity of the ULBT was lower than the MMT, the ULBT had a higher AUC.

A single-blinded observational study by Shah et al[9] evaluated 480 adult patients. Excluded patients were those not able to perform either of the tests, those with any malformation of the airway head or neck, and pregnant patients. There were 67 (13.95%) difficult intubations including 65 patients with a CL grade III and 2 patients with a CL grade IV. The sensitivity of the ULBT was 74.63% compared to 70.15% for the MMT. The specificity of the ULBT was 91.53% compared to 61.02% for the MMT. The ULBT PPV was 58.82% compared to 22.6% for the MMT PPV. The ULBT NPV was 95.70% compared to the MMT NPV of 92.65%. The ULBT had a slightly higher percentage of predicted difficult intubations, which were difficult when compared to the MMT; however, the ULBT had a significantly higher percentage of predicted easy intubation, which were easy (P<0.0001).

Haq and Ullah[2] conducted a prospective observational study of 760 adult patients. This study determined that an ULBT of I predicted an easy intubation while a ULBT of II-III predicted a difficult intubation. Patients not able to perform either of the tests, or who were edentulous, pregnant, had a BMI>28kg/m2, or deformities of the head or neck were excluded from the study. There were 17.9% that had a CL III or IV. The UBLT sensitivity was 95.8% compared to 27.0% for the MMT. The specificity of the ULBT was 88.4% compared to 95.7% for the MMT. The ULBT PPV was 70.5%, compared to 64.7% PPV for the MMT. The ULBT NPV was 98.5% compared to an 82.0% NPV for the MMT. The ULBT had a statistically significant (P<0.05) higher percentage of correctly predicted difficult intubations compared to the MMT.

Reference	Sample/ Design	Airway Assessment	Sensitivity/ Specificity	CONCLUSION
Ali et al., 2012[3]	Cross-sectional study N=324 Age>18yr ASA Not given	<table><tr><td></td><td>**E**</td><td>**D**</td></tr><tr><td>**MMT**</td><td>I-II</td><td>III-IV</td></tr><tr><td>**ULBT**</td><td>I-II</td><td>III</td></tr></table> E=Easy D=Difficult	<table><tr><td></td><td>**MMT**</td><td>**ULBT**</td></tr><tr><td>**Sens**</td><td>19.6%</td><td>87.5%</td></tr><tr><td>**PPV**</td><td>33.3%</td><td>71.6%</td></tr><tr><td></td><td></td><td></td></tr><tr><td>**Spec**</td><td>91.8%</td><td>92.9%</td></tr><tr><td>**NPV**</td><td>84.8%</td><td>97.3%</td></tr></table> Sens=Sensitivity Spec=Specificity PPV=Positive Predictive Value NPV=Negative Predictive Value	The ULBT showed a higher percentage of correctly predicted difficult intubations when compared to the MMT (P<0.05). Both ULBT and MMT were similar in correctly predicting easy intubations.
Badheka et al., 2016[4]	Single blinded prospective observational study N=170 Age 20-70yrs ASA I-III	<table><tr><td></td><td>**E**</td><td>**D**</td></tr><tr><td>**MMT**</td><td>I-II</td><td>III-IV</td></tr><tr><td>**ULBT**</td><td>I-II</td><td>III</td></tr></table>	<table><tr><td></td><td>**MMT**</td><td>**ULBT**</td></tr><tr><td>**Sens**</td><td>78.9%</td><td>96.6%</td></tr><tr><td>**PPV**</td><td>85.4%</td><td>92.7%</td></tr><tr><td></td><td></td><td></td></tr><tr><td>**Spec**</td><td>68.6%</td><td>82.3%</td></tr><tr><td>**NPV**</td><td>58.3%</td><td>91.3%</td></tr></table>	The ULBT had a higher percentage of predicting difficult intubations as well as easy intubations when compared to the MMT.
Wajekar et al., 2015[5]	Prospective comparative, double-blind study N=402 Age>18yrs ASA I-II	<table><tr><td></td><td>**E**</td><td>**D**</td></tr><tr><td>**MMT**</td><td>I-II</td><td>III-IV</td></tr><tr><td>**ULBT**</td><td>I-II</td><td>III</td></tr></table>	<table><tr><td></td><td>**MMT**</td><td>**ULBT**</td></tr><tr><td>**Sens**</td><td>90.4%</td><td>98.6%</td></tr><tr><td>**PPV**</td><td>91.0%</td><td>89.3%</td></tr><tr><td></td><td></td><td></td></tr><tr><td>**Spec**</td><td>30.4%</td><td>8.7%</td></tr><tr><td>**NPV**</td><td>29.2%</td><td>44.4%</td></tr></table>	The ULBT was slightly more specific in predicting difficult intubations. A high number of predicted easy intubations were difficult.
Honarmand et al., 2014[6]	Prospective observational blind study N=525 Age >18yrs ASA I-III	<table><tr><td></td><td>**E**</td><td>**D**</td></tr><tr><td>**MMT**</td><td>I-II</td><td>III-IV</td></tr><tr><td>**ULBT**</td><td>I</td><td>II-III</td></tr></table>	<table><tr><td></td><td>**MMT**</td><td>**ULBT**</td></tr><tr><td>**Sens**</td><td>68.6%</td><td>90.2%</td></tr><tr><td>**PPV**</td><td>13.6%</td><td>19.3%</td></tr><tr><td></td><td></td><td></td></tr><tr><td>**Spec**</td><td>52.8%</td><td>59.4%</td></tr><tr><td>**NPV**</td><td>94.0%</td><td>98.3%</td></tr><tr><td>**AUC**</td><td>0.611</td><td>0.831</td></tr></table>	The ULBT was found to be more clinically accurate (P=0.0001). Many predicted difficult intubations were found to be easy for both the MMT and ULBT. The ULBT AUC was significantly

								more compared to the MMT AUC.

Study	Design		E	D			MMT	ULBT	Findings
Safavi et al., 2014[7]	Randomized prospective double-blind study N=467 Age >18yrs ASA I-III	MMT	I-II	III-IV		Sens	63.6%	75.7%	The ULBT was found to be more clinically accurate. The ULBT AUC was significantly more compared to the MMT AUC.
						PPV	8.2%	22.7%	
		ULBT	I-II	III					
						Spec	46.9%	80.8%	
						NPV	94.4%	97.8%	
						AUC	0.569	0.820	
Safavi et al., 2011[8]	Prospective observational study N=603 Age >18yrs ASA I-III	MMT	I-II	III-IV		Sens	87.3%	66.0%	A high number of intubations MMT predicted easy, were difficult. The ULBT AUC was significantly more compared to the MMT AUC.
						PPV	93.3%	97.1%	
		ULBT	I-II	III					
						Spec	14.6%	73.1%	
						NPV	7.8%	13.6%	
						AUC	0.511	0.709	
Shah et al., 2013[9]	Prospective observational study N=480 Age >18yrs ASA I-II	MMT	I-II	III-IV		Sens	70.1%	74.6%	The ULBT had a slightly higher predictability of difficult intubations, however, it had a significantly higher percentage of identifying easy intubations. A high number of MMT predicted difficult, were easy.
						PPV	22.6%	58.8%	
		ULBT	I-II	III					
						Spec	61.0%	91.5%	
						NPV	92.6%	95.7%	
Haq & Ullah, 2013[2]	Prospective observational study N=760 Age >18yrs ASA I-III	MMT	I-II	III-IV		Sens	27.0 %	95.8%	The ULBT had a higher percentage of correctly predicted difficult intubations compared to the MMT, which was statistically significant (P <0.05).
						PPV	64.7%	70.5%	
		ULBT	I	II-III					
						Spec	95.7%	88.4%	
						NPV	82.0%	98.5%	

MMT= Modified Mallampati Test

ULBT= Upper Lip Bite Test

Sensitivity= The percentage of difficult intubations which were predicted to be difficult.

PPV= Positive predictive value. The percentage of predicted difficult intubations which were difficult intubations.

Specificity= The percentage of easy intubations which were predicted to be easy.

NPV= Negative predictive value. The percentage of predicted easy intubations which were easy intubations.

AUC= Area under the curve. An area of 1 represents a perfect test, or 100% accuracy; an area of .5 represents a worthless test, or accuracy no greater than chance.

Conclusion

Seven of the eight studies found the ULBT to have a higher sensitivity indicating that when the ULBT predicted a difficult intubation, a higher number were difficult. Safavi et al[8] did not find a higher sensitivity, however, the ULBT AUC was significantly greater (P<0.0001) than the MMT. Three studies included an AUC, which represents both the sensitivity and specificity and is considered a measure of accuracy. All found that the ULBT AUC was significantly more than the MMT AUC.[6,7,8] There was a wide variation in the specificity or number of predicted easy intubations which were easy, 92.9% to 8.7% for the ULBT. In the Wajeker et al[5] study, the ULBT specificity was low at 8.7% with a large number of predicted easy intubations that were actually difficult. The study was an outlier with the next lowest specificity reported at 59% for the ULBT. The lowest specificity for the MMT was 14.6% in the Safavi et al[8] study, whereas the Wajeker et al[5] study reported a MMT specificity of 30.4%.

Some limitations of this evidence-based practice analysis are that all studies included were performed in countries outside the United States (US). This may not take into account the general population and ethnicities found in the US. Another limitation was that one person in each study conducted all assessments. The results could be skewed if the individual did one or both of the assessments poorly. The ULBT also has limitations; it may not be performed in all patients such as an edentulous and non-cooperative patient or patients unable to move their jaw. The ULBT is not a perfect tool to correctly identify 100% of patients with a difficult intubation; however, the review of studies reported a higher level of accuracy when compared to the MMT in predicting difficult intubation.

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