A comparison of the Mallampati test in supine and upright positions with and without phonation in predicting difficult laryngoscopy and intubation: A prospective study

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Abstract

Background and Aims: Difficult ventilation and intubation have been recognized as the forerunners of hypoxic brain damage during anesthesia. To overcome catastrophic events during anesthesia, an assessment of the airway before induction is of paramount importance. We designed this study to compare the effect of phonation on the Mallampati test in supine and upright positions as against the traditionally employed test without phonation in serving to predict difficult laryngoscopy and intubation.

Material and Methods: In this cross-sectional study, 661 patients aged 16-60 years were recruited during the years 2011 to 2012. The Mallampati test was conducted on patients with and without phonation in both the sitting and supine positions. A blinded observer then performed laryngoscopy and intubation. Difficult intubation was assessed according to the Cormack-Lehane Grading scale. Statistical Analysis Used: Diagnostic statistical measures for each of the four situations — sensitivity, specificity, positive and negative predictive values and accuracy — were calculated.

Results: In this study, 28 patients (4.2%) had difficult laryngoscopy and nine patients (1.4%) had difficult intubation. There was no difference in the sensitivity of the Mallampati test as regards prediction of laryngoscopy and intubation in the four different positions, but the upright position along with phonation had the highest specificity. The negative predictive value was above 95% in all the positions; however, the positive predictive value was the highest in the supine position along with phonation.

Conclusion: Based on our results, the supine position along with phonation had the best correlation in the prediction of difficult laryngoscopy and intubation. We further conclude that phonation significantly improved the Mallampati class in the supine position compared with the upright position.

Key words: Cormack — Lehane grade, difficult intubation, Mallampati test, sitting position, supine position

Introduction

Unanticipated difficult laryngoscopic intubation has been a major concern for anesthesiologists, and the incidence ranges from 0.05% to 18%. Failure to maintain the patency of the airway after induction of anesthesia can lead to catastrophic sequelae, such as irreversible brain damage and death. Mallampati et al.[8] suggested a simple screening test for difficulty in airway assessment that is widely used today in its modified form introduced by Samsoon and Young.[5] Several authors have found considerable interobserver variation when using the Mallampati test (M.T.), some of which could be attributed to the execution of the test.[9] Because Mallampati et al.[8] in their original paper did not specify whether the patient should phonate or not, subsequently, phonation has been shown to affect classification. Owing to the fact that no clear-cut direction exists regarding the utilization or non-utilization of phonation during the test performance, we designed this study to test our hypothesis that the Mallampati test could well be performed in the supine position without phonation with equally good results. In this regard, we compared the effect of phonation and no phonation on the Mallampati test in supine and upright positions in an attempt to arrive at the best possible situation for the assessment of the Mallampati test in predicting difficultly in laryngoscopy and intubation.
Material and Methods

In this cross-sectional study, 661 patients aged 16-60 years were recruited during the years 2011 to 2012. An ethical approval was waivered by the ethics committee of our institute as no intervention infringing patient’s safety was involved; however, all patients who gave an informed consent entered the study. Inclusion criteria comprised of all patients scheduled to undergo endotracheal intubation for general anesthesia. Patients entered the study without any randomization of positions because each patient had to be subjected to all the four situations. Exclusion criteria included ASA class higher than II, urgency of the situation, facial, mouth, throat and airway anomalies, pregnancy and awake intubation.

Mallampati class was assessed with the head in full extension, the mouth wide open and the tongue extruded in the upright position with and without phonation, and again in the supine position with phonation and in the absence of phonation. While conducting the M.T in the supine position, the head was placed on a pillow that could elevate the head approximately 10 cm above the horizontal level. The oropharyngeal structure during each of the four categories was classified as below:[10]

Class 0: The ability to visualize any part of the epiglottis on mouth opening.
Class I: Soft palate, fauces, uvula and pillars seen.
Class II: Soft palate, fauces and uvula seen.
Class III: Soft palate and base of the uvula seen.
Class IV: Soft palate not visible at all.

Mallampati classes 0, I and II were declared to be easy and classes III and IV were considered to be difficult.

During intubation, a blinded observer with at least 5 years experience in clinical anesthesia graded the laryngoscopy grade according to the Cormack — Lehane grading (CLG)[11] score as below:

Grade I: Full view of the glottis
Grade II: Partial view of the glottis is arytenoid
Grade III: Only epiglottis visible
Grade IV: Neither glottis nor epiglottis is visible

CLG scores I and II were classified as easy intubations whereas grades III and IV were classified as difficult intubations. If three attempts failed to provide a good glottis exposure, alternative measures for intubation were initiated, such as the use of a bougie or employing a fiberscope. A patient was dubbed as a case of difficult intubation if the insertion of the tube took more than 10 min and/or required more than three attempts by an experienced anesthesiologist.[12]

The anesthesia protocol was the same for all patients and comprised of midazolam 0.03 mg/kg and fentanyl 2 μg/kg as premedication drugs, an induction dose of thiopental sodium in the range of 3-5 mg/kg and 0.5 mg/kg of atracurium for skeletal muscle relaxation. Laryngoscopy with subsequent intubation was attempted when a train of four stimulations showed disappearance of the second twitch.

Data were analyzed using SPSS version 18.00. For quantitative data, maximum, minimum and mean ± SD and for qualitative data, the number (percentage) were reported. The Chi-square test was used for the relationship between qualitative variables. Kappa agreement, sensitivity, specificity, positive and negative predictive values and accuracy were calculated for each of the situations. A \( P \)-value <0.05 was considered to be significant.

Results

Difficultly in laryngoscopy was found in 28 (4.2%) of the patients, and nine (1.4%) patients were found to have difficult intubation.

The demographic data of the patients are depicted in Table 1.

Sensitivity (Se), Specificity (Sp), Positive Predictive Value (PPV) and Negative Predictive Value (NPV) of the Mallampati test during different positions as assessed during laryngoscopy revealed the best kappa in both the upright and the supine positions with accompanying phonations.

As depicted in Table 3, the Se, Sp and NPV were the highest in the upright position without phonation compared with the other positions.

We found that the Mallampati test both during laryngoscopy and during intubation fared well in both the supine and

| Table 1: Demographic data of the patients |
| Coexisting variables | Test variables | Frequency | Percentage |
|------------------------------------------|----------------|------------|------------|
| Sex                                      | Male           | 295        | 44.6       |
|                                          | Female         | 366        | 55.4       |
| ASA a class                              | I              | 506        | 76.6       |
|                                          | II             | 155        | 23.4       |
| DMb + RAc                                | Yes            | 34         | 5.1        |
|                                          | No             | 627        | 94.9       |
| Agec                                     | ≤40            | 469        | 71.0       |
|                                          | >40            | 192        | 29.0       |
| BMIc                                     | <30            | 599        | 90.6       |
|                                          | ≥30            | 62         | 9.4        |

aAmerican Society of Anesthesiologists, bDiabetes Mellitus, cRheumatoid Arthritis, dBody Mass Index (kg/m²)
upright positions without phonation and fetched the highest Se, whereas this Se was lower when phonation was attempted by the patient in the said positions [Tables 2 and 3].

The test had the highest Sp both during laryngoscopy and during intubation in both the upright and the supine positions with phonation, but it was found to be the lowest in both supine and upright positions not accompanied with phonation [Tables 2 and 3].

The Sp was found to be high and acceptable in all the different positions, but the highest figures were seen in the presence of phonation.

The PPV in both positions and situations was low.

On the other hand, the NPV tested in all the four situations was above 95%, and it had a good correlation with the test of agreement (kappa). However, the kappa agreement test revealed that the best correlation was in the supine plus phonation and upright plus phonation positions.

The kappa agreement for the Mallampati test in different positions and statuses could reveal that the best correlation was in the upright position with phonation and supine position with phonation. The highest correlation was with the supine plus phonation position in the prediction of difficult laryngoscopy and intubation, but, compared with the other situations, the correlation was not significant.

The kappa agreement regarding Se, Sp, PPV and NPV in all the different positions for laryngoscopy and intubation regarding other variables such as age gender, ASA class, body mass index (BMI) and diseases such as diabetes and rheumatoid arthritis failed to show a significant difference ($P > 0.05$).

This study shows that the Mallampati class that went high in the supine phonation caused an improvement in the Mallampati class, i.e. changing a higher class to a lower class.

**Discussion**

Anatomical factors and characteristics are of considerable importance in predicting difficulty in intubation but have limitations because of their variability from one person to another and in the same person at different periods of life. This interobserver variability has been considered to be a major limitation of the Mallampati classification. The original paper of Mallampati et al. [8] did not explicitly mention whether the patient should phonate while the test is being performed or not; subsequently, it has been observed that phonation affects the classification. Lewis et al. [13] found that the results of the Mallampati classification are more reproducible when the tongue is protruded during phonation. On the contrary, many

**Table 2: Se, Sp, PPV and NPV of the Mallampati test in different positions and phonation status regarding laryngoscopy**

| Cormack and Lehane | Upright + no phonation | Supine + no phonation | Upright + phonation | Supine + phonation |
|--------------------|------------------------|-----------------------|---------------------|--------------------|
| Value | 95% CI | Value | 95% CI | Value | 95% CI | Value | 95% CI |
| Sen* | 67.86 | 49.42 | 86.30 | 67.86 | 49.42 | 86.30 | 28.57 | 10.73 | 46.41 |
| Spb | 81.67 | 78.65 | 84.70 | 72.67 | 69.19 | 76.15 | 95.26 | 93.60 | 96.92 |
| PPVc | 14.07 | 8.13 | 20.02 | 9.90 | 5.63 | 14.16 | 21.05 | 7.47 | 34.63 |
| NPVd | 98.29 | 97.18 | 99.40 | 98.08 | 96.83 | 99.33 | 96.8 | 95.1 | 98.5 |
| Kappa agreement | 0.175 | 0.107 | 0.204 | 0.287 |
| Acc* | 0.81 | 0.72 | 0.92 | 0.92 |

*Sensitivity, *Specificity, *Positive predictive value, *Negative predictive value, *Accuracy

**Table 3: Se, Sp, PPV and NPV of the Mallampati test in different positions and phonation status as regards endotracheal intubation**

| Intubated | Upright + no phonation | Supine + no phonation | Upright + phonation | Supine + phonation |
|-----------|------------------------|-----------------------|---------------------|--------------------|
| Value | 95% CI | Value | 95% CI | Value | 95% CI | Value | 95% CI |
| Sen* | 88.89 | 63.27 | 100 | 77.78 | 43.88 | 100 | 44.44 | 3.93 | 84.96 |
| Spb | 80.52 | 77.47 | 83.57 | 71.63 | 68.16 | 75.10 | 94.79 | 93.07 | 96.50 |
| PPVc | 5.93 | 1.89 | 9.96 | 3.65 | 0.97 | 6.32 | 10.53 | 0.30 | 20.75 |
| NPVd | 99.81 | 99.44 | 100 | 99.57 | 98.98 | 100 | 99.20 | 98.49 | 99.90 |
| Kappa agreement | 0.08 | 0.045 | 0.152 | 0.2 |
| Acc* | 0.81 | 0.72 | 0.94 | 0.93 |

*Sensitivity, *Specificity, *Positive Predictive Value, *Negative Predictive Value, *Accuracy
others studies have reported that gagging or phonation results in unpredictable motion of the pharynx and should therefore be avoided as it may obstruct the view.\cite{9,11,13-16}

In the present study, the Mallampati test as compared with the laryngoscopic and intubation exposures had the highest Se in the supine plus no phonation and upright plus no phonation situations. The highest Sp on the other hand was seen in the upright plus phonation and supine plus phonation positions. The lowest Se was found in the upright plus phonation situation and the lowest Sp was seen in the upright plus no phonation and supine plus no phonation situations.

Our findings show that the Mallampati test correctly depicts difficulty in intubation when the test is performed without phonation. During phonation, the number of false-negatives increases or, in other words, the test erroneously depicts an increase in the number of easy intubations that are in fact difficult. This would lead to an increase of apprehension among the anesthesiologists as difficult intubations would be predicted as easy intubations. Our findings corroborate with that of other studies\cite{13-16} that state that gagging or phonation affects the Mallampati class and should best be avoided. These findings are in sharp contrast to those of Lewis et al.,\cite{13} who found that phonation did not influence the overall accuracy of the Mallampati test. Tram et al.\cite{17} failed to find a significant difference in the Mallampati classification in the supine and upright positions. Such variations in the conduct of Mallampati tests may contribute to some of the heterogeneity of the results seen in systematic reviews.

The study by Singhal et al.\cite{18} showed that variations in patient’s position can affect the Mallampati class, and found that the Mallampati score was improved by one or two classes in the supine position rather than in the upright position. Bindra et al.\cite{19} in their study showed that phonation significantly improved the Mallampati class and that change in position from upright to supine could bring a very small change in the oropharyngeal view. Our findings also revealed that there was an improvement in the Mallampati class in the supine position with phonation and a higher class was changed into a lower class.

The PPV was found to be low in all the positions; however, compared with other positions, it was negligibly higher in the supine plus phonation position. There is exceedingly low probability that the test would prove to be reliable in predicting difficulty in intubation, and this conforms with several studies\cite{5,14,15,20} conducted so far. The NPV had been high in all the four situations. This could confirm that the test would prove to be of value in predicting easy intubations and, regarding this variable, one could rely on its validity.

In this study, the Se, Sp, PPV and NPV in all the Mallampati test positions and situations showed a suitable kappa coefficient in evaluation with laryngoscopy and intubation. The best kappa, however, was seen in the upright plus phonation and supine plus phonation situations. Also, the highest level of kappa was seen in the supine position along with phonation. But, the overall difference between the four Mallampati test situations for kappa was not significant.

Our study demonstrated that Se, Sp, PPV and NPV in all the Mallampati test positions had suitable kappa coefficient in evaluation with laryngoscopy and intubation as regards the other variables such as gender, age, ASA class, BMI and coexisting diseases such as diabetes mellitus and rheumatoid arthritis failed to show any significant difference.

Our study supports our hypothesis that phonation affects the Mallampati class and, to prevent false Mallampati negatives, it seems that Mallampati class could fetch the best results if performed without phonation. In other words, patients who did not phonate had a higher Se. Compared with the upright position without phonation, the Se of the test was equally high in the supine position, giving credence to our claim that the test would prove to be of value in patients who cannot adopt the upright posture.

Apart from the limitations inherent in conducting the Mallampati test, there were no other limitations. However, we presume that there might be some among the elderly who would perhaps fail to follow the directions, leading to false outcomes.

### Conclusion

Our findings reveal that the Mallampati class was high in the supine position and that the Mallampati class had improved in the supine position coupled with phonation. The test had poor results in predicting difficulty in laryngoscopy and intubation and had high false-positive and false-negative outcome. Moreover, the test conducted in the supine position with phonation had a better kappa and agreement in determining difficulty in laryngoscopy and intubation.

### References

1. Shiga T, Wajima Z, Inouo T, Sakamoto. A Predicting difficult intubation in apparently normal patients: A meta analysis of bedside screening test performance. Anesthesiology 2005;103:429-37.
2. 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.
3. Benumof JL. Management of the difficult adult airway. With special emphasis on awake tracheal intubation. Anesthesiology 1991;75:1087-110.
4. Schwartz DE, Matthay MA, Cohen NH. Death and other complications of emergency airway management in critically ill adults. A prospective investigation of 297 tracheal intubations. Anesthesiology 1995;82:367-76.
5. Samsoon GL, Young JR. Difficult tracheal intubation: A retrospective study. Anaesthesia 1987;42:487-90.
6. Caplan RA, Posner KL, Ward RJ, Cheney FW. Adverse respiratory events in anaesthesia: A closed claims analysis. Anesthesiology 1990;72:828-33.
7. Rose DK, Cohen MM. The airway: Problems and predictions in 18,500 patients. Can J Anaesth 1994;41:1105-11.
12. Benumof JL. The ASA difficult airway algorithm: New thoughts and considerations. Annual refresher course lectures. Par Ridge, IL, USA: Am Soc Anesthesiologists 1997;241:1-7.
13. Lewis M, Karamati S, Benumof JL, Berry CC. What is the best way to determine oropharyngeal classification and mandibular space length to predict difficult laryngoscopy? Anesthesiology 1994;81:69-75.
14. Frerk CM. Predicting difficult intubation. Anesthesia 1991;46:1005-8.
15. Jacobsen J, Jensen E, Waldau T, Poulsen TD. Preoperative evaluation of intubation conditions in patients scheduled for elective surgery. Acta Anaesthesiol Scand 1996;40:421-4.
16. Wilson ME, John R. Problems with the Mallampati sign. Anaesthesia 1990;45:486-7.
17. Tham DJ, Gildersleeve CD, Sanders LD, Mapleson WW, Vaughan RS. Effects of posture, phonation, and observer on Mallampati classification. Br J Anaesth 1992;68:32-8.
18. Singhal V, Sharma M, Prabhakar H, Ali Z, Singh GP Effect of posture on mouth opening and modified Mallampati classification for airway assessment. J Anesth 2009;23:463-5.
19. Bindra A, Prabhakar H, Singh GP, Ali Z, Singh V. Is the modified Mallampati test performed in supine position a reliable predictor of difficult tracheal intubation? J Anesth 2010;24:482-5.
20. Lee A, Fan LT, Gin T, Karmakar MK, Ngaan Kee WD. A systematic review (meta-analysis) of the accuracy of the Mallampati tests to predict the difficult airway. Anesth Analg 2006;102:1867-78.

**Conference Calendar 2015**

| Name of conference | Dates | Venue | Name of organising secretary with contact details |
|--------------------|-------|-------|--------------------------------------------------|
| 17th Annual Conference of Indian Society of Neuroanesthesiology and Critical Care | February 5th-7th 2016 | Bengaluru | Dr. Venkatesh H K Telephone: +91 9738974930 Email: inacc2016@gmail.com Website: http://inacc2016.org/index.html |
| 22nd Annual Conference of Indian Society of Critical Care Medicine & International Sepsis Forum CRITICARE | February 5th-9th 2016 | Agra | Dr. Ranvir Singh Tyagi, Dr. Diptimala Agarwal Telephone: +91 9927778889 Email: criticare2016@gmail.com Website: http://criticare2016.com/ |
| 23rd International Conference of the Indian Association of Palliative Care IAPCON | February 12th-14th 2016 | Pune | Dr. Priyadarshini Kulkarni Telephone: +91 9158286161 Email: info@iapcon2016pune.com Website: http://iapcon2016pune.in/index.html |

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