

## Research Article

# Phonation Improves the Correlation Between Mallampati Evaluation and Laryngoscopic View

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Citation: Lebowitz PW, Shetty N, BA, Nair S (2017) Phonation Improves the Correlation Between Mallampati Evaluation and Laryngoscopic View. Anesth Med Pract J: AMPJ-112. DOI:10.29011/AMPJ-112/100012

Received Date: 14 September, 2017; Accepted Date: 18 September, 2017; Published Date: 26 September, 2017

### Abstract

**Background:** Mallampati classification has become virtually ubiquitous as part of preoperative patient evaluation in current anesthetic practice despite studies that have shown it to be an imprecise predictor of laryngoscopic view. This test as originally described assesses the visibility of pharyngeal structures without phonation. Since phonation raises the soft palate, we sought to evaluate whether phonation improves the correlation of Mallampati class with Cormack-Lehane grade.

**Methods:** After obtaining IRB approval, we recruited adult patients who were undergoing elective surgery with planned general anesthesia and tracheal intubation. Each patient underwent two preoperative Mallampati evaluations - one without and one with phonation-by a trained study investigator. The patient's anesthetist was subsequently asked to assess that patient's Cormack-Lehane grade. We analyzed the data for correlations.

**Results:** We studied 492 patients whose Mallampati scores were 2.77 +/- 1.09 without phonation and 1.89 +/-0.99 with phonation. The Pearson correlation coefficient was 0.145 without phonation and was 0.177 with phonation ( $p<0.001$ ). The kappa statistic for concordance was 0.006 without phonation and was 0.145 with phonation ( $p<0.001$ ). Similarly, the odds ratio for predicting difficult laryngeal visualization was 2.2 without phonation and was 3.5 with phonation. The sensitivity of the test was 0.74 without phonation and was 0.52 with phonation. The specificity was 0.44 without phonation and 0.76 with phonation.

**Conclusions:** Mallampati evaluation as a stand-alone test is an insensitive and non-specific indicator of laryngoscopic view-without or with phonation. However, adding phonation to the Mallampati evaluation significantly improves correlation with conventional laryngoscopic view.

**Keywords:** Laryngoscopy; Mallampati evaluation; Phonation

### Introduction

The reported rate of difficult laryngoscopy and/or tracheal intubation during general anesthesia has ranged from 1.5 to 8% [1]. Consequently, anesthesiologists have sought to find a reliable bedside method for predicting laryngoscopic ease or difficulty in individual patients. The most utilized approach in current practice is the Mallampati method, which is based on the visibility of the uvula, faucial pillars, and soft palate with the patient seated upright, the head neutral, the tongue protruded, and no phonation.

Although the original Mallampati study demonstrated accurate prediction of difficult intubation with 100% specificity [2], subsequent studies have shown more modest correlations. A meta-analysis of Mallampati studies concluded that the test has limited accuracy in predicting a difficult airway and, thus, is not a useful screening test [3].

Phonation frequently improves the Mallampati score [4]. The objective of our study was to determine the correlation of Mallampati classification, with and without phonation, with laryngoscopic view as measured by Cormack-Lehane grading during standard clinical laryngoscopy. Our study hypothesis was that

phonation improves the correlation between Mallampati class and Cormack-Lehane grade.

## Materials and Methods

After obtaining approval from Montefiore Medical Center's Institutional Review Board, we recruited consecutive patients age 18 or greater who were undergoing elective surgery with planned general anesthesia and tracheal intubation. In as much as the study did not require collection of patient identifying information, the IRB granted a waiver of signed informed consent. We excluded pregnant women, patients who were unable to cooperate with a Mallampati evaluation, patients requiring rapid sequence intubation, and patients for whom the attending anesthesiologist planned to use an advanced intubation technique, such as video laryngoscopy or fiber optic laryngoscopy.

Each patient underwent two Mallampati evaluations by a single trained study coordinator – one examination conducted in the standard fashion (uvular, pharyngeal, and palatal visualization with the patient's mouth widely open and the tongue maximally protruded with the patient sitting upright and the head neutral, without phonation) and a second standard examination, but with phonation. The patient was asked to phonate by clearly saying "Ah." Patients were also evaluated for abnormalities in neck extension, thyromental distance, dentition, and neck circumference, as well as for airway pathology.

In every case, the patient's anesthetist (attending anesthesiologists, residents, or CRNAs) induced general anesthesia using his or her choice of induction agents, neuromuscular blocking drugs, and laryngoscope blade. The anesthetist then performed a laryngoscopy and tracheal intubation in the normal course of events. Soon thereafter, the study coordinator then showed the anesthetist a schematic of Cormack-Lehane grading and recorded the grade determined by the anesthetist.

Because previous studies have demonstrated that Mallampati class as a stand-alone factor is a poor tool to predict difficult laryngoscopic view, we did not perform an a priori sample size calculation but, instead, used a convenient method of sampling to enroll subjects into the study. We used descriptive statistics (mean

and standard deviation for continuous variables and percentages for categorical variables) to characterize the study population. We assessed the correlation between different Mallampati class and Cormack-Lehane grade using Pearson (r) correlation coefficients. We used Cohen's kappa statistic to evaluate the agreement between different Mallampati classes and Cormack-Lehane grades in predicting difficult laryngoscopic view.

Finally, we pooled subjects into two groups combining Mallampati class 1 and 2 subjects and, separately, Mallampati class 3 and 4 subjects, then evaluated the correlations - with and without phonation. Similarly, subjects were re-grouped into Cormack-Lehane 1 and 2 subjects and, separately, Cormack-Lehane 3 and 4 subjects, then evaluated the correlations-with and without phonation. We calculated odds ratios (95% CI) as well as established the sensitivity and specificity (95% CI) of predicting difficult laryngoscopic view for each group. All reported p values were 2-sided, and p value < 0.05 was considered to be statistically significant. All analyses were performed using SPSS version 21.0 (SPSS Inc., Chicago IL).

## Results

We studied 492 patients of whom 63.8% were male and 36.2% were female. The mean age was 50.3 years (+/- 15.4), the mean weight was 87.3 kg (+/- 25.2), and the mean neck circumference was 38.6 cm (+/- 4.3). The Cormack-Lehane grade for patients classified as Mallampati 1 without phonation varied as follows: 71.2% (grade 1), 21.1% (grade 2), 3.9% (grade 3), and 3.9% (grade 4). When compared with the same patients evaluated with phonation, the Cormack-Lehane grades were 74.2% (grade 1), 20.9% (grade 2), 3.1% (grade 3), and 1.8% (grade 4). [Tables 1,2,3,4]

The Cormack-Lehane grade for patients classified as Mallampati 4 without phonation varied as follows: 55.0% (grade 1), 26.9% (grade 2), 12.9% (grade 3), and 5.3% (grade 4). The corresponding percentages for patients evaluated with phonation were 68.2% (grade 1), 15.9% (grade 2), 11.4% (grade 3), and 4.5% (grade 4). The Cormack-Lehane grading for Mallampati classes 2 and 3 are also listed in [Tables 1,2,3,4].

Mallampati without Phonation			Cormack-Lehane Grade				Total
			1	2	3	4	
Mallampati Class	1	Count	54	16	3	3	76
		% of Mallampati	11%	3%	1%	1%	15%
	2	Count	91	34	4	3	132
		% of Mallampati	19%	7%	1%	1%	27%
	3	Count	76	31	2	4	113
		% of Mallampati	15%	6%	0%	1%	23%
	4	Count	94	46	22	9	171
		% of Mallampati	19%	9%	5%	2%	35%
<b>Total</b>		Count % of Total Cormack-Lehane	315	127	31	19	492
			64%	26%	6%	4%	100%

**Table 1:** Mallampati without Phonation, Number and percentage of patients in each Mallampati class (without phonation) and their corresponding Cormack-Lehane grade.

Mallampati with Phonation			Cormack-Lehane Grade				Total
			1	2	3	4	
Mallampati Class	1	Count	167	47	7	4	225
		% of Mallampati	34%	10%	1%	1%	46%
	2	Count	76	49	6	7	138
		% of Mallampati	15%	10%	1%	1%	28%
	3	Count	42	24	13	6	85
		% of Mallampati	9%	5%	3%	1%	17%
	4	Count	30	7	5	2	44
		% of Mallampati	6%	1%	1%	0%	9%
<b>Total</b>		Count	315	127	31	19	492
		% of Total Cormack-Lehane	64%	26%	6%	4%	100%

**Table 2:** Mallampati with Phonation, Number and percentage of patients in each Mallampati class (with phonation) and their corresponding Cormack-Lehane grade.

Cormack-Lehane without Phonation			Mallampati Class				Total
			1	2	3	4	
Cormack-Lehane Grade	1	Count	54	91	76	94	315
		% of Cormack-Lehane	11%	19%	15%	19%	64%
	2	Count	16	34	31	46	127
		% of Cormack-Lehane	3%	7%	6%	9%	26%
	3	Count	3	4	2	22	31
		% of Cormack-Lehane	1%	1%	0%	5%	6%
	4	Count	3	3	4	9	19
		% of Cormack-Lehane	1%	1%	1%	2%	4%
<b>Total</b>		Count	76	132	113	171	492
		% of Total Mallampati	15%	27%	23%	35%	100%

**Table 3:** Cormack-Lehane without Phonation, Number and percentage of patients in each Cormack-Lehane grade (without phonation) and their corresponding Mallampati class.

Cormack-Lehane with Phonation			Mallampati Class				Total
			1	2	3	4	
Cormack-Lehane Grade	1	Count	167	76	42	30	315
		% of Cormack-Lehane	34%	1%	9%	6%	64%
	2	Count	47	49	24	7	127
		% of Cormack-Lehane	10%	10%	5%	1%	26%
	3	Count	7	6	13	5	31
		% of Cormack-Lehane	1%	1%	3%	1%	6%
	4	Count	4	7	6	2	19
		% of Cormack-Lehane	1%	1%	1%	0%	4%
Total		Count	225	138	85	44	492
		% of Total Mallampati	46%	28%	17%	9%	100%

**Table 4:** Cormack-Lehane with Phonation, Number and percentage of patients in each Cormack-Lehane grade (with phonation) and their corresponding Mallampati class.

The mean and standard deviation of Mallampati scores for all studied patients without phonation and with phonation were 2.77+/-1.09 and 1.89+/-0.99, respectively. Patients were classified without phonation into Mallampati class 3 or 4 in 57.7% of cases. However, when Mallampati with phonation was evaluated in the same cohort, only 26.2% of patients fell within class 3 or 4. The Pearson correlation coefficient (r) for Mallampati class without phonation and Cormack-Lehane grade was 0.145, whereas the Pearson correlation coefficient for Mallampati class with phonation and Cormack-Lehane grade was .177 (p <0.001).

We examined the correlations of Mallampati classes and Cormack-Lehane grades to establish concordances with and without phonation. The kappa statistic for Mallampati without phonation was 0.006 (95%CI -0.02928 to 0.04128) (p=.729), whereas the kappa statistic for Mallampati with phonation was 0.145 (95%CI = 0.08424 to 0.20576) (p<0.001).

We additionally calculated the odds ratio of laryngoscopic difficulty by pooling the data into two groups: all the patients in Mallampati class 1 and 2 who were also graded as Cormack-Lehane 1 and 2; and, separately, all the patients in Mallampati class 3 and 4 who were also graded as Cormack-Lehane 3 and 4. The odds ratio for predicting difficult laryngeal visualization with Mallampati without phonation was 2.2 (95% CI 1.1-4.3) while the odds ratio with Mallampati with phonation was 3.5 (95% CI 1.9-6.4).

The sensitivity of the test without phonation was 0.74 (CI 0.59-0.84) whereas the sensitivity with phonation was 0.52 (CI 0.37-0.66). The specificity of the test without phonation was 0.44 (CI 0.39-0.48) while the specificity with phonation was 0.76 (CI

0.72-0.80). The positive predictive value without phonation was 0.13 (CI 0.09-0.17) and was 0.20 (CI 0.13-0.28) with phonation. The negative predictive value without phonation was 0.93 (CI 0.89-0.96) and was 0.93 (CI 0.90-0.95) with phonation.

## Discussion

The purpose of our study was to determine the efficacy of phonation during a preoperative Mallampati examination, as compared with a standard, non-phonation Mallampati evaluation. Our results show a higher kappa coefficient when phonation is used than when phonation is not included. Consequently, phonation slightly improved the concordance of a specific Mallampati class with its corresponding Cormack-Lehane grade.

Numerous studies have examined the correlation of Mallampati classification with ease or difficulty of tracheal intubation, and their conclusions have generally held that this test has weak prognostic capability [5]. However, these studies have been inconsistent in considering phonation or non-phonation as a defining element of the test. Amadasun et al did look at phonation in a group of 390 patients, but did so with the patient sitting upright and the neck maximally extended [4]. They found that phonation improved Mallampati classification but reduced its correlation with Cormack-Lehane grading. Oates et al prospectively studied 334 patients and described a high false-negative rate with both the standard Mallampati and Mallampati with phonation tests. However, they found only 6 of the 334 patients (0.02%) to be a “Difficult intubation” [6]. Khan et al evaluated 661 patients with and without phonation in both the supine and upright positions and determined that there was no difference in sensitivity among

all four situations, though the highest specificity occurred with phonation and upright position. Confusing the matter, however, they concluded that the highest positive predictive value came with phonation and supine position [7].

Other studies have described a sensitivity of only 50% for the standard Mallampati examination and a false-positive rate as high as 90% [5,8,9]. We saw this high false-positive rate in our study as well. The Mallampati without phonation group assessed as class 4 had a Cormack-Lehane grade of 1 or 2 in 81.9% of patients; the Mallampati with phonation group assessed as class 4 had a Cormack-Lehane grade of 1 or 2 in 84.1% of the subjects.

Overall, phonation improved the Mallampati classification in our study patients, compared with those noted in the same patients without phonation. For example, although only 54 patients were entered as Mallampati 1 without phonation, 167 had Mallampati 1 classification once phonation was added. This phenomenon has been well documented in other studies [4,6] During phonation, the tongue flattens, and the levator veli palatine muscles contract, pulling the soft palate upwards and backwards. This anatomic/ physiologic relationship may explain why phonation improved the correlation with laryngoscopic view.

Several studies have attempted to address the issue of high false positive correlations by using methods to improve the Mallampati class, such as performing the examination with full neck extension [10,11] This maneuver increased the specificity, though not the sensitivity, of the correlation, compared with the traditional examination.

Interpretation of our results are subject to several confounders: several study coordinators performed the preoperative Mallampati examination, though every pair of evaluations was done by a single study coordinator. Rosen stock et al showed that the interrater reliability of Mallampati classifications is only “Satisfactory-good” ( $\kappa$  0.41-0.80) and is dependent on the experience of the clinician [12]. Similarly, many different anesthetists of varying experience made the Cormack-Lehane determination for each patient in the course of anesthetizing the patients to whom they were assigned. All study subjects were patients at a single institution, and these patient were undergoing a variety of surgical procedures. In addition, a bias likely existed among the supervising attending anesthesiologists to perform video laryngoscopy or fiber optic laryngoscopy in patient whose airways they deemed unsafe to approach through conventional laryngoscopy. Such patients were excluded from the study.

Given these limitations, our study demonstrates that Mallampati classification with phonation offers an advantage over Mallampati classification without phonation in correlating with Cormack-Lehane grades. Although phonation adds concordance

with Cormack-Lehane scores, neither Mallampati evaluation appears to be sufficiently sensitive or specific to rely upon in assessing preoperatively the ease or difficulty of tracheal intubation in a given patient.

As previous studies have shown, the efficacy of Mallampati rating in predicting difficult tracheal intubation improves when combined with other clinical findings, such as neck extensibility and normal thyromental distance. The number of patients in our study with limited neck extension or retrognathia were similar in both groups, and our study was insufficiently powered to assess the difference that either of these conditions might have contributed to an understanding of Mallampati- Cormack-Lehane correlation - without and with phonation. Even so, tracheal intubation was accomplished in all study subjects using conventional laryngoscopy.

## Conclusion

- Mallampati evaluation as a stand-alone test is an insensitive and non-specific indicator of laryngoscopic view and ease of tracheal intubation-without or with phonation.
- Adding phonation to the Mallampati evaluation significantly improves correlation with conventional laryngoscopic view. Consequently, inasmuch as the Mallampati examination has become ubiquitous in anesthetic practice, we recommend that phonation be incorporated into the Mallampati evaluation to enhance the efficacy of predicting laryngoscopic view, however slightly.

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**Citation:** Lebowitz PW, Shetty N, BA, Nair S (2017) Phonation Improves the Correlation Between Mallampati Evaluation and Laryngoscopic View. *Anesth Med Pract J: AMPJ*-112.

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