



Original Research Article

Ultrasound guided airway assessment- an observational study to correlate airway parameter to cormack-lehane grading of laryngoscopy

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ABSTRACT

Introduction and Aim: Securing airway is an important routine for any Anesthesiologist. Assessment of airway preoperatively is an essential part of predicting difficulty in airway management. Mallampati test (MP) is commonly applied during such preoperative assessments. However, Mallampati test is an indirect clinical sign in which thickness of the base of the tongue is assessed by whether it masks faucial pillar (palatoglossal and palatopharyngeal arches) or not. Though MP is an indirect assessment, this test is routinely applied because of ease of applying this test. This test however is not completely reliable in predicting difficulty in laryngoscopy and intubation and has high false-positive and false-negative outcome. The depth of floor of the mouth and thickness of tongue can be assessed to improve prediction of difficult airway. This depth can be measured by cheap and rapid test using ultrasonography.

Material and Methods: In this study depth of the tissues in the floor of the mouth were measured by placing USG probe above hyoid bone in sagittal plane and measurement taken from skin to mucous membrane of tongue and attempted to establish any relationship between this thickness and difficulty in laryngoscopy as assessed by Cormack-Lehane scoring.

60 ASA I & II patients undergoing elective surgeries under GA were assessed during the pre-anaesthetic evaluation and supra-hyoid USG depth in sagittal plane was measured and recorded. During laryngoscopy Cormack and Lehanne scoring was recorded for each of the subjects by 2 experienced anaesthesiologists who were blinded to the depth assessment.

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1. Introduction

Securing airway is an important routine for any Anaesthesiologist. A difficult airway is defined as the clinical situation in which a conventionally trained Anaesthesiologist experiences difficulty in face mask ventilation of the upper airway, difficulty with tracheal intubation or both. Adverse outcome of difficult airway include damage to teeth, airway trauma, need for surgical airway, cardiopulmonary arrest, brain injury or even death. A preoperative airway evaluation plays a vital role to reduce mortality and morbidity related to difficult airway. Airway evaluation is done by proper history taking, physical

examination and additional evaluation.^{1–3} There exist many tests, measurements and scores which are routinely applied by Anaesthesiologists for airway evaluation. Mallampati test is one of the widely used, because of its simplicity. This is applied for evaluation of airway in almost all cases. According to Mallampati hypothesis, airway difficulty is encountered due to disproportional large base of tongue. If base of tongue is disproportionately large, it will be difficult to lift up the tongue during laryngoscopy. Apparently, any clinical tool or measurement is not available which detects thickness of the base of the tongue. Mallampati (MP) test is an indirect clinical sign in which depth of the base of the tongue is assessed by whether it masks faucial pillar (palatoglossal and palatopharyngeal arches) or

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not.⁴ As MP is an indirect assessment, this test sometimes fares poorly in predicting difficulty in laryngoscopy and intubation and has high false-positive and false-negative outcomes.⁵ Radiography, computed tomography (CT) and fluoroscopy used as additional evaluation described by ASA Task Force, among which CT scan may reveal depth of base of tongue.¹ However, this investigation is costly, and no relationship has been established among depth of base of tongue and difficulty in laryngoscopy. This depth can be measured by cheap and rapid test using ultrasonography (USG). In this study depth is measured by placing USG probe above hyoid bone in sagittal plane and measurement taken from skin to mucous membrane of tongue and attempted to establish any relationship between this thickness and difficulty in laryngoscopy. Difficulty in laryngoscopy is tabulated in terms of modified Cormack Lehane gradation.^{6,7} We explored the possibility of using a simple yet effective objective measure to predict airway difficulty. Our measurement of depth can be standardised and does not need higher expertise to apply. This test can be done as a routine pre-op evaluation as it is non-invasive and can be done in a short time.

1.1. Sonoanatomy

Oral cavity is filled with air, so if ultrasound probe is placed above hyoid bone at sagittal plane, structures visible are skin, subcutaneous tissue, deep cervical fascia, mylohyoid muscle, geniohyoid muscle, genioglossus muscle, intrinsic muscles of tongue and mucus membrane of tongue⁸ (Figure 1). Maximum depth from skin to mucus membrane of tongue is measured (Figure 2). Any structure beyond the mucus membrane will not be visible because of air.⁹



Fig. 1:

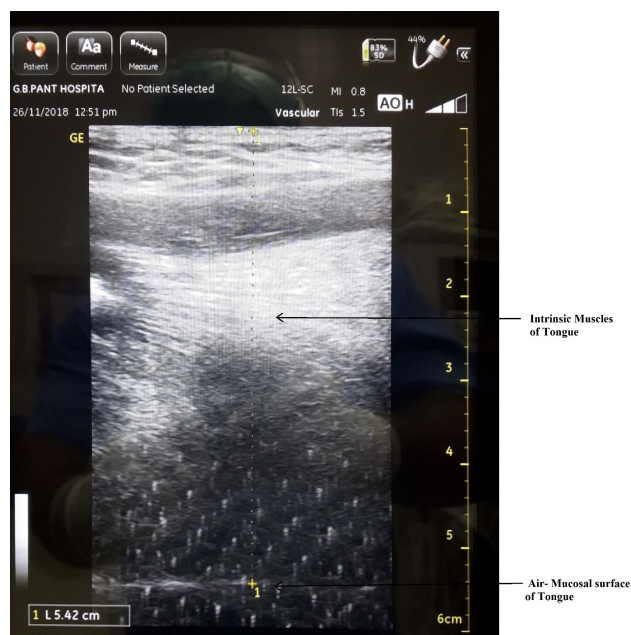


Fig. 2:

2. Materials and Methods

A prospective study was conducted in a tertiary care hospital within 1 year, 2017-18. After clearance from ethical committee & Institutional Review Board, 60 patients were enrolled who fulfilled inclusion criteria for the study. Patients included were those who underwent general anaesthesia for elective non-obstetric surgeries with ASA Physical status I or II, with age between 15 & 65 years and who had distance of tongue mucosal layer from skin less than 6 cm by Ultrasonography. Airway evaluation for the enrolled patients were done at Pre-Anaesthetic check-up clinic after taking consent. Mallampati test as modified by Samssoon & Young were performed and recorded.¹⁰ Depth of posterior 1/3rd of tongue was taken using Ultrasound Machine (GE Healthcare, Venue 40) with a linear array probe. Patients were examined in supine position and head placed in “sniffing” position. After proper lubrication, probe was placed in the sagittal plane at the midline above hyoid bone on the floor of the mouth. If depth was not beyond 6 cm, it was visible and measured from skin to mucosal layer of tongue. All patients were divided in 3 groups according to depth of mucosal layer of tongue from the skin. Group A included those with skin mucosal distance of 3.5-5.4 cm, Group B with 5.5- 5.8 cm and Group C with distance more than 5.8 cm. Before performing laryngoscopy, all patients were given assist-controlled ventilation with 100% O₂ using bag and mask. 1-2 minute after ventilation laryngoscopy attempted by senior Anaesthesiologists, who were unaware about preoperative ultrasound evaluation. Laryngoscopy was done with appropriate size Macintosh Blade. Cormack-Lehane grading were assessed and recorded prior to

intubation.¹¹ According to modified Cormack-Lehane, 5 grades has been described which was used for this study.¹² Difficult laryngoscopy is defined as the inability to visualise the vocal cord which include modified Cormack-Lehane grades 2B, 3, 4. On the other hand, easy laryngoscopy includes grade 1 and 2A (which means only the partial visualisation of glottis).⁶ Airway evaluation by modified Mallampati score and measurement of depth of tongue by USG were done to correlate with the ease of intubation with direct laryngoscopy as indicated by modified Cormack-Lehane grading.

Data was entered into MS-Excel worksheet and analyzed using statistical software IBM SPSS 21.0. Data was presented using descriptive statistics such as frequency, percentage, mean and SD. Further association between variables were tested using chi-square test. The level of significance was set at 5% (p at 0.05). All p-values less than 0.05 were treated as significant. Among 60 patients (n=60) according to USG depth Group A, B and C had 25, 21 and 14 patients respectively. During laryngoscopy, no difficulty was encountered in Group A. However, 19.05% and 57.14% of patients in Group B and Group C respectively had difficult intubation (Table 1).

Table 1: Association between USG Depth & CL

USG Depth	Cormack & Lehane Grade		Total
	Not difficult	Difficult	
Group A	25 (100%)	0 (0.0%)	25
Group B	17 (80.95%)	4 (19.05%)	21
Group C	6 (42.86%)	8 (57.14%)	14
Total	48 (80%)	12 (20%)	60

Chi-square = 18.333, df=2, p < .001, Significant

During Mallampati evaluation, no patient was found to belong to Mallampati class-4 among the study sample. Therefore, Mallampati class 1, 2 and 3 mentioned as MP-1, 2 and 3 accordingly. Among 60 patients MP-1, 2 and 3 included 31, 27 and 2 patients accordingly. Laryngoscopy revealed no difficulty in MP-1 group of patients. MP-2 and 3 encountered difficult intubation 40.7% and 50% accordingly (Table 2).

Table 2: Association between MP & CL

MP	Cormack & Lehane Grade		Total
	Not difficult	Difficult	
MP1	31 (100%)	0 (0.0%)	31
MP2	16 (59.3%)	11 (40.7%)	27
MP3	1 (50.0%)	1 (50.0%)	2
Total	48 (80%)	12 (20%)	60

Chi-square = 16.134, df=2, p < .001, Significant

Regarding association between USG Depth & MP it was found that among all patients of Group A, only 28% belonged to MP-2 and 3 whereas among Group B and C that rate was 52.4% and 78.6% respectively (Table 3).

Table 3: Association between USG Depth & MP

USG Depth	MP			Total
	MP1	MP2	MP3	
Group A	18 (72.0%)	7 (28.0%)	0 (0.0%)	25
Group B	10 (47.6%)	9 (42.9%)	2 (9.5%)	21
Group C	3 (21.4%)	11 (78.6%)	0 (0.0%)	14
Total	31 (51.7%)	27 (45.0%)	2 (3.3%)	60

Chi-square = 13.392, df=3, p < .01, Significant

Sensitivity and specificity of USG guided depth measurement in terms of difficult airway were found to be 75.00% and 88.89% respectively. On the other hand, Sensitivity and specificity of Mallampati evaluation were found to be 52.17% and 97.96% respectively, in terms of difficult airway (Table 4).

Table 4:

USG	Sensitivity	75.00%
	Specificity	88.89%
MP	Sensitivity	52.17%
	Specificity	97.96%

3. Results

Modified Mallampati score was not accurate in the mid-range of difficult airway. It was more specific in predicting difficult intubation. The measurement of distance between of the mucosa of the base of the tongue from skin measured by Ultrasonography as an indicator of airway dimension has more sensitivity to predict difficult airway. It also predicted the borderline difficult intubation scenario more accurately than Modified Mallampati score.

4. Discussion

In spite of all modern amenities, airway management is a challenging job for Anaesthesiologists even today. Incidence of failed tracheal intubation is 1 in 1000-2000.¹³ For Obstetric Rapid Sequence Induction, it is 1 in 250,¹⁴ whereas in emergency department, it is 1 in 100.¹⁵ Unexpected or un-predicted difficulty are a major cause for airway related morbidity and mortality. In Indian scenario, incidence of difficult laryngoscopy is 9.7% and difficult intubation is 4.5%.¹⁶

Therefore pre-operative assessment of airway is important to identify and prepare for management of difficult airway. According to ASA task force guideline evaluation to be done on the basis of history, physical examination and additional evaluation.¹

ASA task force mentioned some additional tests like radiography, computed tomography (CT) and fluoroscopy, based on observational studies and case report (Category B3-B/B4-B evidence).¹ But those tests require expertise as well as are not cost effective. Airway ultrasonography

(USG) is being used in some centres to assess difficulty of airway.

Among all physical examination, Modified Mallampati test is considered as the best with highest positive predictive value i.e. 70% in comparison to upper lip bite test (ULBT) and temporomandibular distance (TMD).¹⁷

A study by Mahmoodpoor et al., also had a similar opinion. According to this study, Mallampati score was considered the best test for prediction of difficult intubation. However, in cases with high susceptibility of difficult intubation and in patients with high Mallampati scores, palm print and 3-3-2 was considered as additional screening tests in prediction of difficult intubations.¹⁸

However, Lee A et al. concluded that Mallampati test has limited accuracy for predicting the difficult airway.¹⁹ Similar opinion of insufficiency of Mallampati score has been described in Cattano D et al.²⁰ This insufficiency can be explained by the anatomical description of Mallampati test in Mallampati SR et al.⁴ According to their hypothesis, Mallampati test is an indirect assessment of thickness of tongue. If the base of the tongue is disproportionally enlarged, then it will overshadow faucial pillar (palatoglossal and palatopharyngeal arches), uvula and pharynx. Because of enlarged base of tongue, difficult laryngoscopy is encountered. Because of indirect assessment, there are chances of getting false positive and false negative cases. In a case report by Skolimowski et al.²¹ it was mentioned that anteroposterior dimension of pharynx was less due to enlarged tongue and difficult laryngoscopy was encountered because of large base of tongue. Their examination is based on visualisation of observable structures in an open mouth which indirectly measures posterior tongue thickness. While Mallampati classification is simple and easy, it is not objective and not very accurate. To overcome this problem in this study we planned a direct objective measurement of depth of the base of the tongue using ultrasound guidance.

In an observational study by Kundra P et al.²² ultrasound imaging has been used to predict difficult airway, as well as in various clinical application like guidance of percutaneous tracheostomy, crico- thyroidotomy, identification of ET tube placement, prediction of DLT size etc. They have used sagittal, parasagittal, transverse and oblique transverse view. For prediction of difficult laryngoscopy in obese patients they took pretracheal soft tissue thickness at vocal cord level, thyroid isthmus and suprasternal notch in millimetre and within 15cm left and right from central axis. Pretracheal soft tissue thickness (average of three readings), more than 28mm and neck circumference more than 50 cm are found to be risk factors for difficult laryngoscopy. However, applying this ultrasound imaging follows a complex protocol which may not be practical for a routine preoperative assessment. This imaging is likely be observer dependent with a high chance of inter operator variability.

Another study done by Singh K et al.²³ ultrasound used in oblique, axial, sagittal and coronal planes with linear and curvilinear probes to evaluate floor of the mouth, upper airway, structure of oral cavity, vallecula and pyriform fossa. Average time took for USG assessment of each patient in their study was 10.4 ± 1.4 min. The protocol mentioned above, requires higher technical expertise. Moreover because of complex algorithm, it is not possible to assess during PAC.

Our study intends to find an observable definite end points for measurement to reduce variability. We also simplified the protocol so that it can be applied in a short time. In this regard a simple measurement of depth of base of tongue as in our study is equally effective in predicting difficult airway. Because of simplicity this assessment can be done during PAC on routine basis. Anaesthesia trainees also can be trained.

5. Conclusion

Depth of posterior $1/3^{rd}$ of tongue as measured by Ultrasound guidance can predict difficulty in laryngoscopy. Because of its simplicity, less inter-observer variation and more predictability, airway ultrasound may be considered as an important tool during pre-operative airway assessment. Supra-hyoid USG depth of more than 5.8 cm. predicts difficulty during laryngoscopy.

6. Source of Funding

None.

7. Conflict of Interest

The authors declare that there is no conflict of interest.

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