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ORIGINAL ARTICLE

Prediction of Difficult Airway Among Pediatric and Adult Patients Scheduled for Ophthalmological Surgeries under General Anesthesia

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ABSTRACT

Objective: To evaluate the sensitivity and specificity of bedside tests for prediction of difficult airway scheduled for ophthalmological surgeries under general anesthesia.

Methods: This prospective study was carried out at Armed Forces Institute of Ophthalmology, Rawalpindi, Pakistan from March 2020 to October 2020. All pediatric and adult patients with American society of anesthesiologist grade I to IV undergoing elective ophthalmological surgeries under general anesthesia were consecutively enrolled. Mallampati grading, sternomental, thyromental distance, and mouth opening used as the predictors tools whereas Cormack and Lehane (CL) classification validated with on table laryngoscopy. Grade I and II were assigned as easy laryngoscopy whereas grade III and IV were declared as difficult intubation.

Results: Of 232 patients, difficult intubation was observed in 36 (15.5%). Sensitivity and specificity of thyromental distance was 80.5% and 99.4% respectively. Whereas sensitivity of mouth opening was 66.6% and specificity was 99.4%. In case of sternomental distance, sensitivity and specificity corresponded to 61.6% and 100% respectively. The sensitivity and specificity of Modified Mallampati Grading was 97.2% and 96.4% respectively. The relationship between CL grading and MMC showed that all the patients with CL grade I had Malampati grade I, i.e., 28 (100%), while all patients with CL grade IV had Malampati grade IV, i.e., 7 (100%).

Conclusion: Bedside tests prove to be useful parameters for prediction of difficult airway at pre-anesthesia assessment among which Mallampati test is most sensitive and specific, subsequently ensuring availability of difficult intubation equipment, which is a focus of concern in third world countries.

Keywords: Airway, Cormack-Lehane grading, Laryngoscopy, Mallampati score, Prevalence.

INTRODUCTION

Predominate and cardinal concern for an anesthetist is airway management. Prevalence of difficult airway, which constitutes of difficult laryngoscopy and difficult intubation, documented to be 1.5 – 20% as elaborated by various studies carried out on different population of patients presenting for discrete surgical procedures with higher propensity in the Emergency department.[1,2] Moreover, it is reported that significant mortality and morbidity attributed to the failure of airway management may be up to 30-40%.[1,2]

Several studies have reported that detrimental effects of hypoxia and hypercarbia could be eminent due to the failure of airway establishment. If difficult airway could be anticipated with the help of defined modalities and interventions risk of anesthesia can be minimized.[3,4]

Various bedside tests such as Upper lip bite test (ULBT), Modified Mallampati Classification (MMC), Thyromental distance (TMD), Sternomental distance (SMD), and mouth opening has been defined in urge to prognosticate difficult airway however none of the independent variable could establish definitive validity.[5,6]

Difficult airway is defined as difficulty encountered at bag-mask ventilation, direct laryngoscopy, or both, with Cormack Lehane (CL) Classification substantially employed to define later. CL Classification segregates the airway to be difficult in Grade III and IV where glottis is not visualized with direct laryngoscopy.[7,8]

The most widely attempted preoperative test is MMC as a pre-operative measure to assess difficult airway. MMC is based on visual assessment of structures in the oropharynx with adequate mouth opening. It grades patient from I to IV with high grade represents difficulty. However, it is recommended to use this test in conjunction with other documented variables, as described by various studies.[9,10]

This study was carried out in an attempt to establish the prevalence and prediction of difficult airway in pediatric

and adult patients undergoing elective ophthalmological surgeries in a tertiary care centre of Pakistan. Additionally to evaluate the diagnostic and prognostic value of bedside tests employed to anticipate difficult airway. The rationale of the study is to emphasize the significance of airway management and the availability of specialized equipment as third world countries are still under-equipped for advanced anesthetic equipment.

METHODS

This prospective study was carried out at Armed Forces Institute of Ophthalmology, Rawalpindi, Pakistan from March 2020 to October 2020 in Pakistan. Endorsement was taken by the hospital ethical research committee (241/ERC).

The minimum sample size (n=232) required for this prospective cross-sectional study was calculated by using the WHO sample size calculator (version 7.4). The rate of difficult intubation is reported to range from 2.8% - 27%, so an average prevalence rate of 14.9% was considered for a two-tailed hypothesis, with 80% study power, 5% precision, 95% confidence interval, and 10% adjustment for attrition.[11]

All patients undergoing elective ophthalmological surgeries under general anesthesia participated in the study. Informed written consent was obtained in pre-anesthetic evaluation by the patient and in the case of children, consent was provided by the parents. Inclusion criteria was nonirritant, school going, cooperative pediatric patients and adults of American society of anesthesiologists status I, II, and III with age range 12 – 75 years. Pregnant patients, with gross abnormality, BMI > 30 kg/m^2, obvious deformity, congenital disorders, partial or complete edentulous were excluded from the study. Additionally, patients who gave a history of certain complications under general anesthesia or difficult intubation were also eliminated from the study.

First, the presence of difficult airway was evaluated according to bedside tests as mouth opening, TMD, SMD, and MMC classification. Later on, the operation table, the relationship between the major difficult airway as established by CL classification, and bedside tests was examined. Patients were excluded if difficult bag-mask ventilation experienced by anaesthetists, the assistance of senior anaesthetists was sought, the first attempt of intubation failed or a different mode than conventional method for endotracheal intubation was employed.

Upon arrival to operation theatre, standard protocols for general anaesthesia were incorporated. Patient identification, procedure elaboration with review of pre-anaesthesia notes were ensured. Electrocardiography, non-invasive blood pressure, pulse oximetry, and end-tidal carbon dioxide monitory was corroborated before induction of anaesthesia. Patients were positioned in sniffing position after neck flexion and placement of pillow under head and adjustment of table height for direct vision of anaesthetist handling airway. Induction was performed with intravenous bolus of propofol at the dose of 1.5 – 2.0 mg /Kg and inhalational agent sevoflurane at the rate of 2.5 – 3.0 minimum alveolar concentration. Intravenous atracurium in a dose of 0.5 mg/Kg was administered after making ventilation certain. The patient was ventilated manually for 03 – 05 minutes and endotracheal intubation using Macintosh laryngoscope blade, size utilized depending on patient age and ideal body weight. For paediatric patients' tube size was calculated employing age, whereas 7.0 or 7.5 was used for adult patients. The endotracheal tube was introduced without the aid of stylet or bougie.

Laryngoscopy and intubation, pre-anaesthesia assessment was performed by the same anaesthetist to avoid individual and technique variability. In case of assistance by senior consultant anaesthetist cases were excluded. The operator recorded CL grading as notified by the anaesthetist performing laryngoscopy, without the reinforcement of cricoid pressure.

The data were entered and analyzed using IBM SPSS (version 23.0) data management software. The descriptive statistics were presented as frequency and percentage for categorical variables including gender and difficult airway intubation predictor tests e.g., Mallampati test, Thyromental distance, Sternomental distance, and mouth opening. Group association were made using the Chi-square test for various predictors of airway. Sensitivity, specificity, positive predictive value, and negative predictive values were calculated for each predictor test. CL grading of laryngoscopy were assessed during intubation as a gold standard, to predict difficult airway. The sensitivity and specificity of various tests were compared with the help of the ROC curve. Results were analyzed with a 95% level of confidence and a p-value of ≤0.05 was considered statistically significant.

RESULTS

A total of 232 patients were enrolled in the study out of which 41 (17.7%) were pediatric patients, i.e., age ≤12 years while 191 (82.3%) were adult patients, i.e., age >12

years. Overall, there were 155 (66.8%) males while 77 (33.2%) females, with 28 (68.3%) males and 13 (31.7%) females in the pediatric group while 127 (66.5%) and 64 (33.5%) males and females in the adult group, respectively. Among the study group, 8 (3.4%) patients were found to have an ASA physical status of grade I, while 138 (59.5%) belonged to ASA physical status grade II and 86(37.06%) had ASA grade III.

An insignificant difference of CL (p-value 0.110), MMC (p-value 0.126), TMD (p-value 0.504), mouth opening (p-value 0.091) and SMD (p-value 0.088) was observed in pediatric and adult group. (Table 1) The rate of difficult airway was found to be 36 (15.5%), following CL grade 3 and above. Among the 41 pediatric group, the prevalence of difficult airway was 3 (7.3%) while among 101 adults the prevalence was 33 (17.20%). According to MMC, 42 (18.1%) patients with grade 3 or 4 were predicted to experience difficult airway, out of which 35 (83.3%) were true positive, and 7 (16.6%) were false-positive cases. According to TMD, 30 (12.9%) patients with TMD of less than 6cm were predicted to experience difficult airway, out of which 29 (96.6%) were true positive and only 1 (3.3%) was false positive. Mouth opening factor of less than 4 cm predicted 25 (10.7%) patients to undergo difficult airway, with 24 (96%) true positive and 1 (4.0%) false-positive case. The SMD of less than 12 cm predicted difficult airway in 22 (9.4%) patients all of which were true positive cases. The comparison of the sensitivity, specificity, positive predictive value, and negative predictive value of MMC, TMD, mouth opening, and SMD to predict the occurrence of difficult intubation. MMC had the highest sensitivity (97.2%) as compared to all other tests while SMD had the highest specificity in predicting difficult airways. Similarly, SMD had a 100% positive predictive value while MMC had the highest negative predictive value (99.4%). (Table 2)

ROC curves shown in figure 1 depicts the sensitivity and specificity of modified mallampati grading, thyromental distance, mouth opening, and sternomental distance. The area under the ROC for MMC was significantly higher (0.968, 95% CI 0.934 – 1.0, p<0.001) in predicting the difficult airway as compared to other tests.

The relationship between CL grading and MMC showed that all the patients with CL grade I had Malampati grade I, i.e., 28 (100%), while all patients with CL grade IV had Malampati grade IV, i.e., 7 (100%). (Table 3)

DISCUSSION

In this study, a considerable number of patients were found to have difficult airway, following CL grade 3 and above. Among the pediatric group, the predominance of difficult airway was almost seven percent while among adults the prevalence was seventeen percent. These results are compatible with previous studies carried out on the subject, as characterized by meta-analysis of 11 studies based on pre-determined tests of mouth opening, TMD, SMD, MMC, upper lip bite test (ULBT), carried out by Roth et al.[12] Difficult laryngoscopy was evaluated with CL Grade III & IV as standard as it is more convenient to describe difficult laryngoscopy rather difficult intubation. Additionally, difficult intubation is attributable to the number of other congenital, anatomical, and acquired (e.g. burns, previous surgeries, and so forth) causes.[13]

Shah et al, predicted difficult airway prevalence with variables of mouth opening, TMD, SMD, and MMC in the Nepalese Population. Conclusion of prevalence 4.9% was established with CL Grade III & IV. [14] Specificity of tests was comparable to this study however, MMC culminated to be more sensitive with results 97.2% versus their delineation of 55%.

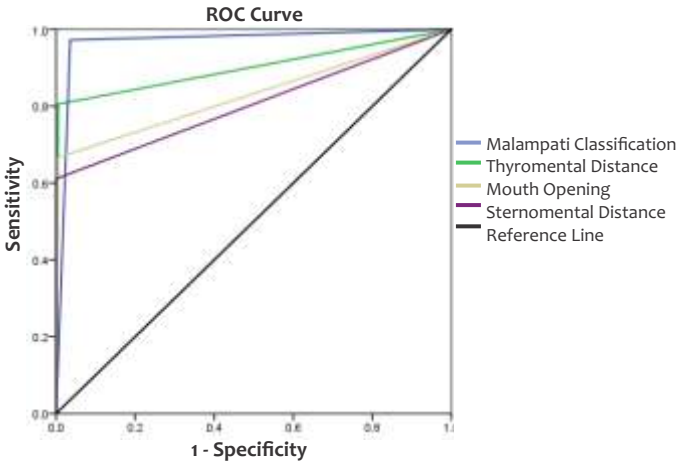

Figure 1: ROC curve for modified mallampati grading, thyromental distance, mouth opening, and sternomental distance to predict difficult airway intubation

Khan et al, elaborated difficult airway prevalence of 5% in prospective trials with utilization of tests such as Upper lip bite test whereas we used MMC, TMD < 6.5 cm, and SMD < 13 cm.[15] Lower cut off values for SMD and TMD ≤12 cm and ≤ 6cm respectively were used to reduce false-positive values. They concluded ULBT more sensitive and specific than SMD and TMD. The specificity of ULBT was 91.69% compared with 82.27% and 70.64% for TMD and SMD respectively. However, they also concluded a combination of techniques to be employed with ULBT and SMD with the highest cumulative sensitivity.

Table 1: Association of study groups with various tests predicting difficult intubation

	Study Groups		P-value
	Pediatric (n=41)	Adult (n=191)	
Cormack and Lehane Grading			
Grade I and II	38 (92.7)	158 (82.7)	0.110~
Grade III and IV	3 (7.3)	33 (17.3)	
Modified Mallampati Grading			
Grade I and II	37 (90.2)	153 (80.1)	0.126~
Grade III and IV	4 (9.8)	38 (19.9)	
Thyromental Distance			
≥6 cm	37 (90.2)	165 (86.4)	0.504~
<6 cm	4 (9.8)	26 (13.6)	
Mouth Opening			
≥4 cm	40 (97.6)	167 (87.4)	0.091*
<4 cm	1 (2.4)	24 (12.6)	
Sternomental Distance			
≥12 cm	41 (100)	169 (88.5)	0.088*
<12 cm	0 (0.00)	22 (11.5)	

All data presented as number (%), *Fisher-exact/~chi-square test applied, p-value ≤ 0.05 considered significant

Table 2: Diagnostic accuracy and Area under the curve of various predictors for airway considering Cormack and Lehane's Grading as Gold Standard

Predictors	Sensitivity	Specificity	PPV	NPV	AUC	95% CI	p-value
Modified Mallampati Grading	97.2%	96.4%	83.3%	99.4%	0.96	0.93 – 1.0	<0.001
Thyromental Distance	80.5%	99.4%	96.6%	96.5%	0.90	0.82 – 0.97	<0.001
Mouth Opening	66.6%	99.4%	96.0%	94.2%	0.83	0.73 – 0.92	<0.001
Sternomental Distance	61.6%	100%	100%	93.3%	0.80	0.70 – 0.90	<0.001

PPV: Positive predicted value, NPV: Negative predicted value, AUC: Area under the curve

Table 3: Comparison between Cormack & Lehane grading and Malampati classification

		Cormack & Lehane grading				Total
		Grade I	Grade II	Grade III	Grade IV	
Malampati classification	Grade I	28	-	-	-	28
	Grade II	1	160	7	-	168
	Grade III	1	-	26	2	29
	Grade IV	-	-	-	7	7
Total		30	160	33	9	232

Vilardell et al, enrolled 1754 pediatric patients undergoing general anesthesia and determined a prevalence of 4.5% which is lower than adult incidence, accordant to our study analysis.[16] Standards set todefine difficult airway were TMD, MMC, interdental space, and atlantoaxial joint mobility. Established sensitivity and specificity of 80% and 98% respectively for predictive tests. Therefore, it is recommended to use similar tests for pediatric and adult patients in incorporation.

Khatiwada et al also determined difficult airway prevalence in the Nepalese population and concluded to be 3.9%, figures much less than statistics observed in this study therefore proposing geographical and ethnic variations.[17] However, MMC concluded to be the most sensitive and specific as the outcome of this study.

Statistics of study are compatible with other endeavors made on the establishment of difficult airway proportions and guidelines. Moreover, as per the study, MMC can be a good indicator in pre-anesthesia assessment, therefore, warranting availability of advanced equipment such as Awake Fiber-optic scopes and, McCoy laryngoscopes, video laryngoscopes, ventilating bougies, cricothyroidotomy and percutaneous tracheostomy kits at time of surgery to prevent never events related to failed intubation. Can't Intubate and Can't (CICV) situation is encountered in 1:5000 cases approximately ultimately leading to the establishment of surgical airway in 1:50000 cases. However, it accounts for up to 25% of anesthesia-related deaths.[18] There is a significant reduction in mortality rate (1:46000 in 1978-82 versus 1:176,000 in 1999) due to difficult airway owing to the availability of equipment and expertise in anesthesia.[19]

This study might have confronted limitations due to a lack of adherence to standard guidelines because of exaggerated workload. Moreover, airway evaluation may be influenced by interpersonal modifications, experience, and shortage of availability of modern equipment for airway management.

Airway evaluation is an important and integral component of pre-anesthesia assessment. Appropriate assessment and logical implementation with utilization of bedside tests as amalgamation is of prime significance to minimize potential airway perplexity and consequently corroborate patient safety as none of the tests exclusively provides 100% credibility. However, there is not any definitive technique to intercept unanticipated difficult airway. Documentation and communication of any encountered trouble are crucial for management, also, to use of conjunction of Mallampati Classification, Thyromental distance, Sternomental distance, and advanced radiological evaluation. Multicenter studies are to be carried out under National Emblem by Anesthesia Professionals to develop pre-anesthesia guidelines and safe airway practices. Revolution in anesthetic equipment for airway management such as availability of video laryngo-scopes, Fibreoptic scopes, and invasive modalities is to be made accessible to every anesthetist in every part of the world especially in underdeveloped and poorly resourced countries.

CONCLUSION

Bedside tests prove to be useful parameters for prediction of difficult airway at Pre Anesthesia Assessment among which Mallampati test is most sensitive and specific, subsequently ensuring availability of difficult intubation equipment, which is a focus of concern in third world countries.

ETHICAL APPROVAL: This study was approved by Ethical Review Committee of Armed Forces Institute of Ophthalmology, Rawalpindi.

AUTHORS' CONTRIBUTION: SA: Conception of the idea, principal investigation, drafting of the article. AR: Final approval of the article to be published, critical analysis of the content. US: Interpretation of the data for work, data analysis.

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