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PREOPERATIVE ASSESSMENT OF VARIABLES TO PREDICT DIFFICULT INTUBATION IN PATIENTS UNDERGOING SURGERIES UNDER GENERAL ANAESTHESIA

Anaesthesiology

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ABSTRACT

Background- Advance prediction of difficult airway provides us ample time for optimal preparation of equipment and participation of experienced anaesthesiologist to handle difficult airway. The present study was designed to evaluate the efficacy of Upper Lip Bite Test (ULBT), Ratio of neck circumference (NC) and thyromental distance (TMD) and Arne Risk Index in predicting difficult airway.

Material and methods- This prospective observational study was conducted on 250 patients, aged 18-60 years of ASA grade I and II scheduled for surgeries under general anaesthesia. Three screening tests i.e. ULBT, NC/TMD and Arne Risk Index were used to predict difficult airway. Number of patients successfully intubated, number of attempts taken for intubation and time taken for intubation was noted. Difficult intubation was calculated using Intubation Difficulty Score (IDS). All the three screening tests were compared for their sensitivity, specificity, negative predictive value (NPV) and Positive predictive value (PPV) to predict difficult airway.

Result- The incidence of difficult intubation was found to be 6.8%. 233 (95.2%) patients were intubated in first attempt and 12 (4.8%) patients were intubated in second attempt and there was no failed intubation. Arne Risk Index had high sensitivity (88.23%), high specificity (88.84%), highest NPV (99.04%) and PPV of 36.58%. ULBT has sensitivity of 76.47%, specificity of 88.41%, NPV of 98.09% and PPV of 32.50% and NC/TMD has sensitivity of 47.05%, specificity of 87.98%, PPV of 22.22% and NPV of 95.79% in predicting difficult airway.

Conclusion- Arne Risk index, a multivariate clinical risk index had highest sensitivity, specificity, NPV and PPV to predict difficult airway.

KEYWORDS

Difficult intubation, Upper Lip Bite Test, Ratio of Neck circumference and thyromental distance i.e. NC/TMD, Arne Risk Index

INTRODUCTION

The primary goal of an anaesthesiologist is to maintain patency of the airway for proper ventilation and oxygenation. Failure to maintain oxygenation after induction of anaesthesia accounts for 30% mortality among patients undergoing general anaesthesia.[1,2] The actual magnitude of difficult airway in anaesthesia practice is typically estimated around 1% to 3%.[3]However, actual difficulty during tracheal intubation occurs in 1.5%–8% of patients.[4] Hence, prediction of difficult airway remains a pivotal challenge for anaesthesiologists. Unanticipated difficult airway causes a stressful situation, if a competent personnel and appropriate equipment is not readily available to handle difficult airway.Prediction of difficult airway in advance provides us ample time for optimal preparation of equipment and participation of experienced anaesthesiologist to handle difficult airway. The most challenging situation for an anaesthesiologist is to reliably identify difficult airways in general population who have apparently normal airways. Various screening tests are being used during airway examination to predict airway difficulty in advance. Ideal clinical variables used to assess difficult airway should be easy to perform, timely and cost effective. They should predict unanticipated difficult airway with minimum errors, have high sensitivity and specificity. Previous literature is available where predictive values of various screening tests were evaluated but most of the studies were conducted on Caucasian population. As the racial differences in the body habitus and craniofacial features affect the upper airway morphology, screening methods used in Caucasian population cannot be extrapolated to Indian population.[5,6] Present study was designed to predict difficult airway in Indian population using individual screening tests i.e. Upper Lip Bite Test (ULBT), Ratio of neck circumference (NC) and Thyromental Distance (TMD) i.e. NC/TMD and Arne Risk Index. Primary aim of the study was to compare sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of the three screening tests used to predict difficult airway. Secondary aim was to calculate the number of patients successfully intubated, attempts taken for intubation and time taken for intubation.

MATERIALS AND METHODS

This prospective observational study was conducted in 250 patients, aged 18-60 years of ASA grade I and II scheduled to undergo elective surgeries under general anaesthesia after taking approval from Institutional Ethical Committee (BFUHS/2k19p-TH/10857). Patients with visible anatomical abnormality of head and neck, history of recent sore throat or upper airway infection, patients of ASA grade III and IV and pregnant women were excluded. All patients included in the study were examined in detail during preanaesthetic checkup after taking fully informed consent in their vernacular language. In clinical History, history of Obstructive sleep apnea (OSA), snoring, hoarseness of voice, previous history of difficult intubation was taken. Detailed examination was done regarding built, posture, sacral symmetry, beard, any burn scar, neck growth or abscess and tracheostomy scar. Body mass index was also calculated. Systemic Examination was done for respiratory system, cardiovascular system and nervous system. All routine investigations were done. Airway examination was done using Upper Lip Bite Test (ULBT), ratio of neck circumference and Thyromental distance i.e. NC/TMD and Arne Risk Index. Upper Lip Bite Test as proposed by Khan was performed on all the patients in which Class 3 (lower incisors unable to bite upper lip) was taken as difficult airway.[7] Ratio of neck circumference (NC) and thyromental distance (TMD) i.e. NC/TMD was calculated in all the patients. Ratio >5 was taken as difficult airway.[8] Arne Risk Index using 7 parameters including previous knowledge of difficult intubation, any airway pathologies and clinical symptoms associated, interincisor gap and mandible subluxation, thyromental distance, head and neck movements and Modified Mallampati test was used during airway assessment in which patients having score >11 was taken as difficult airway.[9] On the day of surgery, patients were kept fasting for eight hours. Difficult airway cart with Mcintosh laryngoscope blade of all sizes, Mccoy blade, ETT of all sizes, oropharyngeal airway, stylet, bougie, videolaryngoscope and suction apparatus was kept ready. All patients were given Tab Alprazolam 0.25mg night before the surgery and early morning on the day of surgery. On arrival, in the operating room, Ringer Lactate was started after securing intravenous line. Multipara monitor was attached to the patient and continuous monitoring of pulse rate, blood pressure, respiratory rate, Spo2 and ECG was done. Injection midazolam 0.03-0.05mg/kg intravenous was given as premedication. General anaesthesia was induced using

propofol 2 mg/kg body weight, bag and mask ventilation was done. Injection succinyl choline 1.5 mg/kg was given followed by intermittent positive pressure ventilation. Laryngoscopy was done by senior anaesthesiologist using Macintosh laryngoscope blade, vocal cords were visualized and endotracheal tube of appropriate size was introduced. In case of difficulty in laryngoscopy or intubation, head repositioning, laryngeal pressure or lifting force was applied. If still not able to intubate then change of laryngoscope blade, use of stylet or bougie or videolaryngoscope was used. Number of attempts for intubation, success or failure of intubation and time taken for intubation was noted. Difficult intubation was assessed using Intubation difficulty score (IDS) having seven parameters i.e. number of attempts for intubation, change of operator, use of alternate techniques, Cormack and Lehane grade, lifting force and laryngeal pressure required and position of vocal cords noted and total score was calculated. Score of 5 or more than 5 was taken as difficult intubation.[10] Anaesthesia was maintained with 50% oxygen, 50% nitrous oxide, isoflurane and injection vecuronium. At the completion of surgery, neuromuscular blockade was reversed, suctioning done and patients were extubated. Continuous monitoring of hemodynamic parameters was done intraoperatively and postoperatively. Patients were assessed for any complications like cough, hoarseness, dry mouth, nausea and vomiting in postoperative period. For all the three airway screening tests, sensitivity, specificity, positive predictive value, negative predictive value were calculated and compared with each other.

STATISTICAL ANALYSIS

Data with complete information were entered to Epi info version 3.4. and then exported to SPSS version 20 for analysis. The association between different independent variables and outcome variables were evaluated using the chi-square test for qualitative data and the Student's t test for quantitative data. The p value less than 0.05 was regarded as significant. A binary logistic regression and multivariate analysis were computed to assess the independent predictive factors and strength of association between the outcome and explanatory variables, with data from 250 patients. The validity of parameters (screening tests) such as sensitivity, specificity was performed using the crosstabs on SPSS whereas positive predictive values and negative predictive values were calculated manually from the descriptive statistics. In Arne Risk Index, seven criteria as independent predictors of difficult tracheal intubation were identified by logistic regression who were assigned point values. The discriminant point values assigned to each statistically significant predictor was then multiplied by a fixed value and rounded to the nearest whole number to derive a "point" value suitable for clinical purposes that lead to a simplified score. Sample size was calculated in consultation with statistician taking success rate and intubation time in consideration and based on previous studies to get the power of study more than 80%.

OBSERVATION AND RESULTS -

Among 250 patients included in this study, 177 (70.80%) were female patients and 73 (29.20%) were male patients. 149 (59.6%) patients were of 18-40 years and 101 (40.4%) patients were of 41-60 years of age. 198(79.20%) patients belonged to ASA grade I and 35 (14%) patients to ASA grade II. Body mass index (BMI) was calculated in all the patients. 24 (9.6%) patients had BMI of >27.5kg/m2 and 226 (90.4%) patients had BMI < 27.5kg/m2 as shown in table 1.

Table 1: Demographic profile of patients

PARAMETERS	NUMBER OF PATIENTS (%)
1.AGE (years)	
18-40	149(59.6%)
41-60	101(40.4%)
2.SEX	
Male	73(29.20%)
Female	177(70.80%)
3.ASA grade	
Grade I	198(79.20%)
Grade II	35(14%)
4.BMI	
>27.5kg/m2	24(9.6%)
<27.5kg/m2	226(90.4%)

In the present study, incidence of difficult intubation was 6.8% (17/250). Among 250 patients, there were no failed intubation. 68(27.20%) patients had [IDS score = 0] easy intubation. 165(66.0%) had IDS score <5 and were intubated without any difficulty. 5 (2.0%) patients had IDS score = 5, slight difficulty was encountered in these patients during intubation. 12 (4.80%) patients had IDS score of more than 5 and major difficulty in intubation was encountered and were intubated in second attempt, either with change of position or change of equipment and operator. Mean time taken for intubation in patients who were intubated in second attempt was 359.16± 67.48 seconds. 238 (95.2%) patients were intubated in first attempt and mean time taken for their intubation was 22.00± 12.49 seconds.

During preoperative assessment using upper lip bite test, 77 (30.80%) patients were in class 1, 133 (53.20%) in class 2 and 40 (16.00%) patients were in class 3. Hence, ULBT predicted difficult intubation in 40 (16.00%) patients. Actual difficulty encountered during intubation by IDS was in 13 (32.50%) patients of class 3 grade, 3 (2.25%) patients in class 2 and 1 patient (1.29%) in class 1 grade as shown in Table 2. Hence, ULBT had specificity of 88.41%, sensitivity of 76.47%, negative predictive value of 98.09% and positive predictive value of 32.50% in predicting difficult airway.

Table 2: Difficult intubation predicted by Upper Lip Bite Test

Upper Lip Bite Test (ULBT)	Number of patients (Percentage)	Number of patients having Difficult intubation (Percentage)
Class 1	77 (30.80%)	1 (1.29%)
Class 2	133 (53.20%)	3 (2.25%)
Class 3	40 (16.00%)	13 (32.50%)
Total	250	17

Among 250 patients, difficult intubation predicted by ratio of neck circumference and thyromental distance was in 36 (14.40%) patients. Actual difficulty encountered during intubation was in 8 (22.22%) patients as shown in table 3. Hence, NC/TMD ratio had sensitivity of 47.05%, specificity of 87.98%, positive predictive value of 22.22% and negative predictive value of 95.79% in predicting difficult airway.

Table 3: Difficult intubation predicted by NC/TMD

Ratio of neck circumference to thyromental distance (NC/TMD)	Number of patients (Percentage)	Number of patients having Difficult intubation (Percentage)
<5	214 (85.60%)	9 (4.20%)
>5	36 (14.40%)	8 (22.22%)
Total	250	17

Among 250 patients, 209 (83.60%) patients had Arne Risk Index <11and 41(16.40%) patients had Arne Risk Index >11. Among 41 patients, actual difficulty in intubation was noted in 15 (36.58%) patients as shown in Table 4. Hence, Arne Risk Index had sensitivity of 88.23% with specificity of 88.84%. The test had positive predictive value of 36.58% and negative predictive value of 99.04% in predicting difficult airway.

Table 4: Difficult intubation predicted by Arne Risk Index

Arne Risk Index	Number of patients (Percentage)	Number of patients having Difficult intubation (Percentage)
<11	209 (83.60%)	2 (0.95%)
>11	41 (16.40%)	15 (36.58%)
Total	250	17

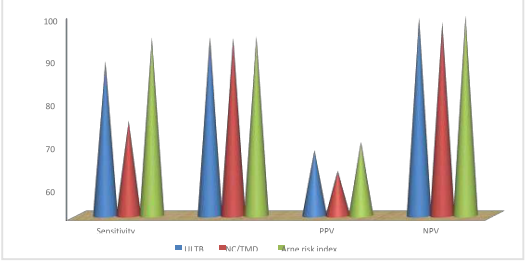

Figure 1: Comparative evaluation of ULBT, NC/TMD and Arne Risk Index

ULBT – Upper Lip Bite test
NC/TMD- Ratio of neck circumference to thyromental distance

Hemodynamic parameters remained stable in all patients during

intraoperative and postoperative period. No postoperative complications were observed in any patient.

DISCUSSION-

Difficult intubation remains a nightmare for the practicing anaesthesiologists as unanticipated difficult airway may lead to catastrophic complications for which the attending anaesthesiologist may not be fully prepared to deal with.

In the present study, incidence of difficult intubation was 6.8% i.e. 17 patients out of 250 patients had difficulty in intubation. Among them, 5 (2%) patients had IDS score of 5 and were intubated in first attempt only and 12 (4.8%) patients had IDS score of more than 5 who were intubated in second attempt, took longer time for intubation [359.16± 67.48 seconds] as these patients required either repositioning, stylet, bougie, change of laryngoscope blade or change of operator. Previous study done by Parkash S et al[11] reported incidence of difficulty in laryngoscopy as 9.7% and difficulty in intubation as 4.5% in patients undergoing general anaesthesia. Tamire T et al[12] reported incidence of difficult intubation as 5% and Shiga T et al[13] reported 5.8%.

In the present study, incidence of difficult intubation was almost similar in male and female patients and there was no positive correlation between ASA grade and difficult intubation. However, there was positive correlation between age and body mass index with difficulty in intubation. Among 17 patients who had difficulty in intubation, 14 patients were in the age group of more than 40 years. Previous studies also observed positive correlation between increasing age and difficult intubation. With increasing age, there may occur anatomical i.e. tooth decay, loose tooth, decreased range of motion; pathophysiological and cognitive changes which can affect airway management.[12]

In the present study, out of 250 patients, 24 patients had BMI >27.5kg/m2 out of which 8 patients (33.33%) experienced difficulty in intubation. Shailja S et al[14] and Juvin P et al[15] also reported that incidence of difficult intubation was more in obese patients as compared to lean patients. They concluded that obese patients were difficult to mask ventilate, had poor glottic exposure, so require more laryngeal pressure and more lifting force during laryngoscopy.

Preoperative detection of patients with unanticipated difficult airway can potentially reduce morbidity and mortality and enhance patient outcome. Numerous investigators suggested various screening tests to successfully predict difficult airway in advance. Ideal screening test should have high sensitivity and specificity with minimum false positive and false negative values. In the present study, three screening tests, Upper Lip Bite Test (ULBT), Ratio of neck circumference and thyromental distance (NC/TMD) and Arne Risk Index which is a multivariate risk index that combine individual screening test were used to predict difficult airway during preanaesthetic evaluation and were compared for their sensitivity, specificity, PPV and NPV. Sensitivity is the ability of screening test to correctly predict difficult intubations as a proportion of all intubations that were truly difficult. Specificity is the ability to correctly predict easy intubations as a proportion of all intubations that were truly easy. Positive predictive value is the ability to correctly predict difficult intubations as a proportion of all predicted difficult intubations. Negative predictive value is the ability to correctly predict easy intubations as a proportion of all predicted easy intubations.

In the present study, ULBT has high specificity of 88.41%, sensitivity of 76.47%, positive predictive value of 32.50% and high negative predictive value of 98.09%. Results of the present study were comparable with the study done by Khan ZH et al where mallampati test and ULBT were used to assess difficult airway and found that ULBT had sensitivity of 76.5%, specificity of 88.7%, positive predictive value of 28.9% and high negative predictive value of 98.4%.[16] Dhanger S et al[17] observed that ULBT had sensitivity of 80%, high specificity of 96.25%, high negative predictive value of 98.08% in predicting difficult airway. Positive predictive value of this study was high (66.66%) as compared to the present study. Metanalysis was done to assess the accuracy of ULBT in predicting difficult airway. 27 studies were included and it was found that all studies except one study reported specificity of ULBT of more than 85% and a high negative predictive value.[18]

In the present study, NC/TMD had high specificity of 87.98%, low sensitivity of 47.05%, positive predictive value of 22.22% and high negative predictive value of 95.79%. Most of the previous studies were done in obese patients to predict difficult airway using NC/TMD ratio. Basil PM et al observed that NC/TMD had specificity of 89.4% and negative predictive value of 93.7% which are almost similar to the present study but sensitivity (76.9%) and positive predictive value (65.6%) was high which may be due to exclusive obese population included in this study.[8] Similar findings were observed in a study by Kim WH et al[19] in obese patients where they found that NC/TMD had specificity of 83% and negative predictive value of 97.8%. But the positive predictive value (45.5%) and sensitivity (88.2%) of NC/TMD was higher in predicting the difficult airway in this study. Castro D et al also observed that NC/TMD had high specificity and high negative predictive value.[20] Ratio of NC/TMD was also used to predict difficult airway in pregnant patients by Hirmanpour A et al[21] where they found that NC/TMD had specificity of 70%, positive predictive value of 17%, negative predictive value of 97%. The findings of the present study are almost comparable to the above study except sensitivity which is high 71.7% as compared to present study. This difference can be attributed to the fact that this study was done in pregnant females, however, pregnant females were excluded in the present study.

In the present study, Arne Risk Index had sensitivity of 88.23%, specificity of 88.84%, positive predictive value of 36.58% and negative predictive value of 99.04%. Arne J et al developed a multi variate clinical index for prediction of difficult intubation in patients undergoing general and ENT surgeries and found that Arne Risk Index had sensitivity of 94%, specificity of 96%, positive predictive value of 37% and negative predictive value of 99%.[9] The results of the present study are almost comparable to the results of the above study.

Limitation-

Limitation of the study was that as there were no standardized cut off values for preoperative airway parameters and different authors used different cut off values for screening tests which imposed difficulties in comparing findings. Secondly, there may be interpersonal variation in airway management in terms of experience of operator, preparation and availability of equipment.

CONCLUSION-

All the three screening tests were effective in predicting difficult intubation but Arne Risk Index had highest sensitivity, specificity, positive predictive value and negative predictive value as compared to ULBT and NC/TMD. Hence, in conclusion it is advisable to use combination of different variables as Arne Risk index which is multivariate clinical risk index to predict difficult intubation in patients undergoing general anaesthesia.

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