PREDICTABILITY OF DIFFICULT LARYNGOSCOPY AND INTUBATION USING THE CLINICAL AND RADIOLOGICAL IMAGING STUDY- A RANDOMISED CONTROL STUDY

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ABSTRACT

BACKGROUND

Airway management is of prime importance to the anaesthesiologists. Unanticipated difficult laryngoscopy and endotracheal intubation remains a primary concern for the anaesthesiologists. The reported incidence of a difficult laryngoscopy or endotracheal intubation varies from 1.5% to 13% in patients undergoing surgery. Failure to intubate is detected in 0.05-0.35% of the patients. Thus, preoperative airway assessment is of pivotal importance for the anaesthesiologist to predict difficult intubation.

The aim of the study is to study the usefulness of two different airway assessment predictors, a clinical and radiological tool to predict difficult intubation.

MATERIALS AND METHODS

Two hundred and eight patients in the age group of 15-75 years of either sex were included in the study. We assessed the clinical variable: modified Mallampati classification and radiological variable: the atlanto-occipital distance, in all the patients. Patients with tumours or malformations of head and neck and oral cavity, edentulous patients, pregnant patients and those requiring emergency surgeries were excluded. A Cormack-Lehane grade of I and II were considered as easy intubation and III and IV were considered as difficult intubation.

RESULTS

Thirty eight patients had difficult intubation. The sensitivity and specificity of the clinical model were found to be 97.2% and 95.3%, respectively. The sensitivity and specificity of the combined clinical and radiological model were found to be 100% and 95.3%, respectively. The area below the ROC curves measures the probability of the correct prediction of the clinical and the combined models. It was found to be 0.992 and 0.993, respectively. This means that the clinical and combined models correctly predicted the outcome with a probability of 99.2% and 99.3%, respectively.

CONCLUSION

From this study, we found that- 1. Clinical models- Modified Mallampati classification is an important predictor of difficult intubation. 2. Radiological imaging- Atlanto-occipital distance is also an important predictor, but with less sensitivity than the clinical model. 3. The radiological predictor is of more value when it is combined with clinical variable, but of less value as a single predictor.

KEYWORDS

Airway, Difficult Laryngoscopy, Endotracheal Intubation.

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BACKGROUND

Airway management is of prime importance to an anaesthesiologist. For securing the airway, the gold standard is tracheal intubation through direct laryngoscopy, which is used in most of the patients. Unanticipated difficult laryngoscopy and endotracheal intubation remains a primary concern for the anaesthesiologists. 'Cannot intubate- Cannot Ventilate' situation may lead to serious complications like hypoxic brain damage or death. The ease of difficulty in performing each of these maneuvers can be assessed by one or more parameters. Thus, the search for a predictive test that has ease of applicability, reliability and accuracy of prediction (discriminating power) continues.

Thus, we proposed to study the usefulness of different airway assessment predictors using clinical and radiological variables before surgery to the Cormack-Lehane's grading[1] of difficulty in intubation during anaesthesia. The clinical variable used is the modified Mallampati[2] and the radiological variable[3,4,5,6] used is the atlanto-occipital distance. We also evaluated the role of combining the clinical

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and radiological measurement in enhancing the validity in predicting difficult intubation based on Cormack and Lehane grading of direct laryngoscopy.

MATERIALS AND METHODS

This study was conducted in accordance with the ethical standards of the hospital committee. Informed consent from the patients was obtained prior to the proposed surgery. Two hundred and eight patients in the age group of 15-75 years requiring general anaesthesia with endotracheal intubation were enrolled to the study. Preoperative airway assessment with clinical parameter, oropharyngeal class according to the Modified Mallampati classification and radiological parameter, atlanto-occipital distance was done prior to surgery. Atlanto-occipital distance[6] (Figure 1) is the major factor, which limits the extension of head. Longer the atlanto-occipital distance, more space is available for mobility of head with good axis for laryngoscopy and intubation. All the clinical assessments were done by a single anaesthesiologist and the radiological assessment was done by radiologist and was blinded to the study.

Figure 1. Atlanto-Occipital Distance

During general anaesthesia with standard monitors, laryngoscopy and endotracheal intubation was attempted with the patient's head and neck in optimal intubating position using an appropriate size Macintosh curved blade. The glottic view was graded according to the Cormack and Lehane grading. Endotracheal intubation was considered difficult, if Cormack and Lehane grading was III and IV.[7,8] At the end of the surgery, patients were extubated and shifted to the postanaesthesia care unit for further monitoring.

Data analysis was done by entering the observations in SPSS Software Version 20 for Windows. Discriminant analysis and ROC curve is used in the statistical analysis.

RESULTS AND STATISTICS

In the study, 38 patients had difficulty in intubation. In distribution of age to difficult intubation as of Table 1 concerned, 17 patients were less than 40 years of age and 21 patients were more than 40 years. The mean age of easy intubation group was 36.1 ± 11.7 yrs. and that of difficult intubation group was 43.7 ± 13.1 yrs. This was found to be statistically significant and is shown in Table 4.

Age Distribution	Cormack-Lehane Grade				Total
	I	II	III	IV	
18-30	42	13	4	3	62
31-40	47	17	4	6	74
41-50	22	10	0	6	38
51-75	12	7	2	13	34
Total	**123**	**47**	**10**	**28**	**208**

Table 1. Age vs. Difficult Intubation

In distribution of gender against difficult intubation, table 2 shows 16 patients were females and 22 were males. The mean of male and female were not statistically significant and is shown in Table 4.

Gender	Cormack-Lehane Grade				Total
	I	II	III	IV	
Female	56	23	8	8	95
Male	67	24	2	20	113

Table 2. Gender vs. Difficult Intubation

In modified Mallampati class, MMC vs. difficult intubation Table 3 shows 37 patients are true positive, 7 patients are false positive and 164 patients are true negative. The sensitivity and specificity is 100% and 95.90%. The positive predictive value, PPV and negative predictive value, NPV, is 95.90% and 90.24%.

In atlanto-occipital distance vs. difficult intubation (Table 3), among 208 patients, 37 patients are true positive, 10 patients are false positive, 160 patients are true negative and 1 patient is false negative. The sensitivity and specificity is 97.43% and 94.11%. The PPV and NPV is 78.72% and 99.37%.

	Modified Mallampati Class	Atlanto-Occipital Distance
Parameter	**Value**	**Value**
True positive	37	37
False positive	7	10
True negative	164	160
False negative	0	1
Sensitivity	100%	97.43%
Specificity	95.90%	94.11%
PPV	90.24%	78.72%
NPV	100%	99.37%

Table 3. Modified Mallampati Class, Atlanto-Occipital vs. Difficult Intubation

PPV- Positive predictive value; NPV- Negative predictive value.

Univariate analysis of Modified Mallampati Class (MMC) and atlanto-occipital gap data shown in Table 4.

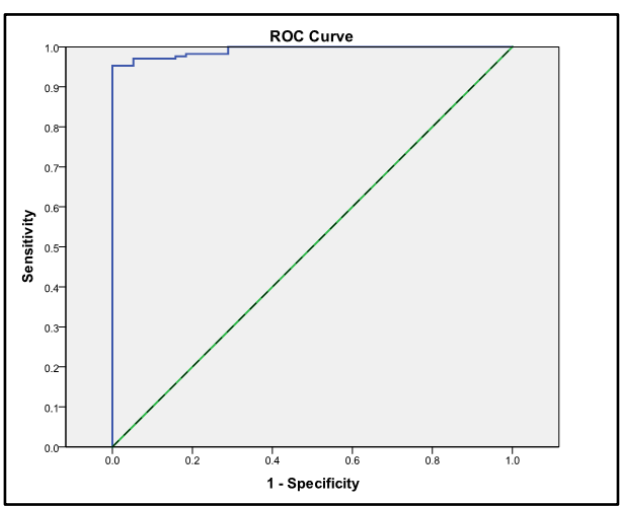
Parameters	Difficult (n=38)	Easy (n=170)	P value
Age	43.7 ± 13.1	36.1 ± 11.7	<0.01
Sex- Male	16	79	0.625
Female	22	91	
Samson and Young Modification of Mallampati			
Class 1	1	139	<0.01
Class 2	0	24	<0.01
Class 3	27	7	<0.01
Class 4	10	0	<0.01
Atlanto-occipital distance	0.44 ± 0.12	1.03 ± 0.23	<0.01

Table 4. Univariate Analysis of MMC and Atlanto-Occipital Gap Data

Clinical Data Alone in the Discriminant Analysis using Stepwise Model

Y = -8.425 + (Samson and Young Modification of Mallampati X - 1.093).

The Receiver Operating Characteristic (ROC) of the clinical model, Graph 1. The sensitivity and specificity of the clinical model were found to be, respectively, 97.2% and 95.3%.



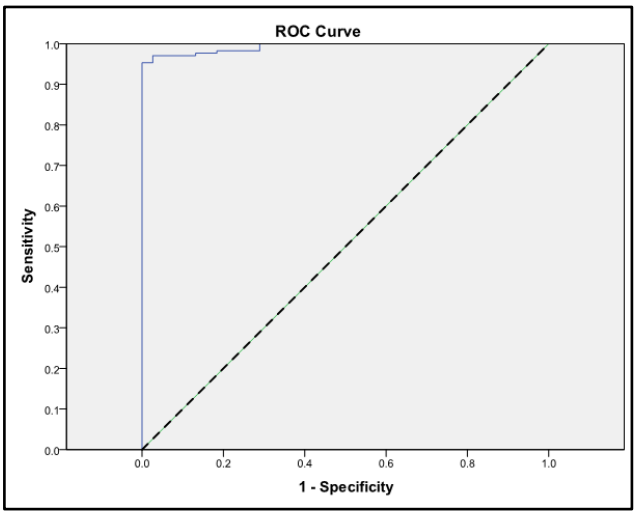
Graph 1. Receiver Operating Characteristic (ROC) of the Clinical Model

Discriminant Analysis of Clinical and Radiological Model

Y = -8.353 + (Samson and Young modification of Mallampati X - 0.986) + (atlanto-occiput distance X 1.079).

The Receiver Operating Characteristic (ROC) of the combined (clinical and radiological) model (Graph 2). The sensitivity and specificity of the combined clinical and radiological model were found to be 100% and 95.3%, respectively.

The area below the ROC curves measures the probability of the correct prediction of the clinical and the combined models. It was found to be 0.992 and 0.993, respectively. This means that the clinical and combined models correctly predicted the outcome with a probability of 99.2% and 99.3%, respectively.



Graph 2. Receiver Operating Characteristic (ROC) of the Combined (Clinical and Radiological) Model

DISCUSSION

Airway management remains an important challenge in the contemporary practice of anaesthesia. Preoperative airway assessment facilitates appropriate preparation when difficulty with intubation or ventilation is anticipated prior to induction of anaesthesia.

Direct laryngoscopy is the gold standard for tracheal intubation. There is no single definition of difficult intubation. Difficult glottic view on direct laryngoscopy is the most common cause of difficult intubation.

We proposed to conduct this study to compare airway assessment factors in patients undergoing surgery requiring general anaesthesia and endotracheal intubation with regards to their sensitivity, specificity, positive predictive value and negative predictive value. Two hundred and eight patients between the ages of 15 and 75 were included in our study. The incidence of difficult intubation in our study was 14%, which is comparable to the results obtained by Frerk[9] and Savva.[10] However, the reported incidence of difficult laryngoscopy or intubation is 1% to 15%.[11] This wide variation in incidence is due to the criteria that are used to define the difficult intubation and different anthropometric features among populations.

There were no failed intubations in our study. There were no patients with difficult mask ventilation during our study.

In our study, we observed a statistical significance in patients having easy intubation compared with patients having difficult intubation with respect to their age, clinical and radiological parameters. This is in concurrence with the study conducted by Hyoung-Yong Moon and his colleagues[12] and Rose and Cohen study. They reported that risk factors for difficult endotracheal intubation being aged 40-59 yrs. In addition, Ezri et al[13] reported that laryngoscopy grades and airway classes increase with age, most likely owing to changes in bone joints and poor dental condition. We noted no statistical significance between male and female gender vs. difficult intubation in our study. Of the 38 patients with difficult intubation, 35 patients were incubated in the first laryngoscopic attempt. These 35 patients were successfully

intubated with an Optimal External Laryngeal Manipulation[14] (OELM), which improved the glottic view by at least one grade. Of the remaining three patients required, one and two laryngoscopic attempts respectively, where in there was no improvement of glottic view on OLEM. One patient required a change of blade size. Gum elastic bougie used for facilitating intubation in CL grade III and IV and were subsequently intubated without any significant events or difficulty. There was neither any significant airway trauma nor episode of desaturation noted. All had no difficulty in mask ventilation.

The discriminant analysis used in this study identified the Clinical Risk Factor (MMC) were predictor of difficult laryngoscopy and intubation. In our study, the sensitivity and specificity of clinical factor was 97.2% and 95.3%. Both clinical and combined models have the highest sensitivity (100%, respectively) and specificity of 95.3%.

In our study, the sensitivity, specificity, PPV and NPV of MMC were found to be 100%, 95.9%, 90.24% and 100% respectively. These were comparable and better prediction than to El-Ganzouri et al,[15] Oates et al[16] and Shiga et al[17] study.

White and Kander[18] reported few radiological measurements, which are included in this study. In our study, only the atlanto-occipital distance have a significant relationship with prediction of difficult intubation. Bellhouse and Dore[6] also predicted difficult intubation with sensitivity of 77% with lateral x-rays.

The Receiver Operating Characteristic (ROC) curve (graph 1 and 2) represents the graphical relationship between sensitivity and specificity. The advantage of ROC analysis is that the area under the ROC curve is independent of both the cut-point criteria chosen and the prevalence of outcome of interest. This allows the comparison of the ROC area between study populations where sensitivity and specificity would be distorted by differences in the prevalence of outcome of interest across populations. A study is considered perfect when the ROC area is 1.0, useless when it is <0.5, low accuracy if the ROC area is between 0.5 and 0.7 and becomes useful with an area = 0.7. The ROC areas observed in this study were high (0.992 and 0.993) indicating good discrimination with the models. This also implies reproducibility.

The use of the discriminant analysis, which calculates a linear combination between parameters improved the predictive potential of our study.

This study demonstrated that models of evaluation that involved combining different clinical (or clinical and radiological) criteria appeared to be sensitive in predicting difficult intubation.

This study can be applied easily in the clinical practice.

CONCLUSION

From the study, we found that-

1. Clinical models- Modified Mallampati classification is an important predictor of difficult intubation.
2. Radiological imaging- Atlanto-occipital distance is also an important predictor, but has lesser sensitivity than the MMC model.
3. The radiological predictor is of more value when it is combined with clinical variable, but not so as a single predictor.

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