RADIOLOGICAL PREDICTORS OF DIFFICULT INTUBATION- A PROSPECTIVE STUDY

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ABSTRACT

BACKGROUND

Anaesthesiologists are confronted daily with the task of determining whether endotracheal intubation will be of increased difficulty in a patient. Several clinical tests were designed to predict difficult intubation. But none of the tests has provided satisfactory results in terms of sensitivity and specificity. A reasonable explanation is that the clinical tests are all physical examinations according to the surface markers, so the effect of bones may not be included. Lateral neck radiography may be regarded as an important predictor of difficult laryngoscopy.

MATERIALS AND METHODS

Two hundred and eight patients in the age group of 25-65 years of either sex were included in the study. We assessed the radiological variables: the atlanto-occipital distance, cervical vertebra C-2 spine depth, effective mandibular length, anterior mandibular depth, posterior mandibular depth 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 Atlanto-Occipital distance has sensitivity and specificity of 97.43% and 94.11%. The PPV and NPV is 78.72% and 99.37%. In Effective Mandibular Length, the sensitivity and specificity are 67.56% and 66.66%. The PPV and NPV is 30.48% and 90.47%. In Anterior Mandibular Depth, the sensitivity and specificity are 77.77% and 51.16%. The PPV and NPV is 25% and 91.66%. In Posterior Mandibular Depth the sensitivity and specificity are 43.24% and 52.04%. The PPV and NPV is 16.32% and 80.90%. In C2 Spine depth the sensitivity and specificity are 48.71% and 59.76%. The PPV and NPV is 21.83% and 83.47%.

CONCLUSION

From this study, we found that 1. Lateral neck radiography is useful but unable to provide good sensitivity in prediction of difficult intubation. 2. Only the atlanto-occipital distance variable has significant sensitivity and specificity as a single radiological predictor.

KEYWORDS

Lateral X- ray, Difficult, Laryngoscopy, Endotracheal Intubation.

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BACKGROUND

The most challenging task for the anaesthesiologists is the management of difficult airway. The incidence rate of difficult intubation is estimated to 1.5%-13%,[1-6] approximately. An unanticipated difficult endotracheal intubation or failed endotracheal intubation is frequently cited as a cause of anaesthesia related morbidity in otherwise healthy patients. The difficult laryngoscopy is a multifactorial problem, so it is crucial to predict difficult intubation before the induction of anaesthesia and intubation. Although prediction and forecasting are a tough task, prediction of difficult laryngoscopy and intubation has gained importance because of the serious consequences of failed tracheal intubation.[7] Nevertheless, no clinical test or system of tests (multifactorial prediction concept)[8-12] has proved to be completely sensitive or specific for the difficult laryngoscopic intubation. Even with the use of multivariate factors there have been instances where a patient predicted to have difficult intubation had an easy intubation and vice versa. So, predicting a difficult intubation employing a myriad of measurements and observations has not demonstrated itself to be practicable or even reliable.

Thus, the search for a predictive test that has ease of applicability, reliability and accuracy of prediction (discriminating power) continues. Using this concept, one can determine how sensitive and specific these tests are and also obtain the positive and negative predictive values of

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these tests. Current bedside tests have limited and inconsistent capacity to discriminate between patients with difficult and easy intubation.[13] It is generally accepted that the well-known clinical tests such as Modified Mallampati test,[14] inter incisor gap and thyromental distance,[15] have considerable false positive and false-negative rates in prediction of difficult laryngoscopy.[16-18] The role of radiography in prediction of difficult intubation had been analysed in some studies.[19-22] Therefore, this study was designed, conducted and was suspected that lateral neck radiography could predict difficult tracheal intubation so perfectly. This study identifies and compares the variables most useful in predicting difficult laryngoscopy and intubation from radiological [lateral x-ray] measurements using Sensitivity, Specificity, Positive Predictive value, Negative Predictive value.

The Radiological [Lateral X-ray] Measurements are

a. Atlanto-occipital distance[23]
b. Effective mandibular length[23]
c. Anterior mandibular length[23]
d. Posterior mandibular length[23-24]
e. C-2 spine depth[23]

MATERIALS AND METHODS

Institutional ethical committee clearance and written informed consent from the patients were obtained prior to the proposed study. Two hundred and eight adult patients aged 25–65 years of age requiring surgery under general anaesthesia with endotracheal intubation are enrolled in our study.

Exclusion Criteria

1. Edentulous patients and patients without both upper and lower incisors,
2. Patients undergoing emergency surgeries and requiring rapid sequence intubation,
3. Patients with obvious neck or oral malformations, tumours involving upper airway,
4. Pregnancy

All patients underwent a routine pre-anaesthetic assessment prior to surgery.[25] A general physical examination was done on all patients along with laboratory investigations, ECG and lateral neck X-ray. The enrolled patients were subjected to the following radiological parameters assessment preoperatively:

Atlanto-Occipital Gap[23]

It is measured from the tip of the spine of atlas to the occiput. Atlanto-occipital distance is the major factor which limits the extension of head on neck. Longer the A-O gap, more space is available for mobility of head at that joint with good axis for laryngoscopy and intubation. Figure 1.

Figure 1. Atlanto-Occipital Distance

Effective Mandibular Depth[23]

It is measured from the tip of the lower incisor to the temporomandibular joint. An increase in length denotes significant difficult intubation. Figure 2.

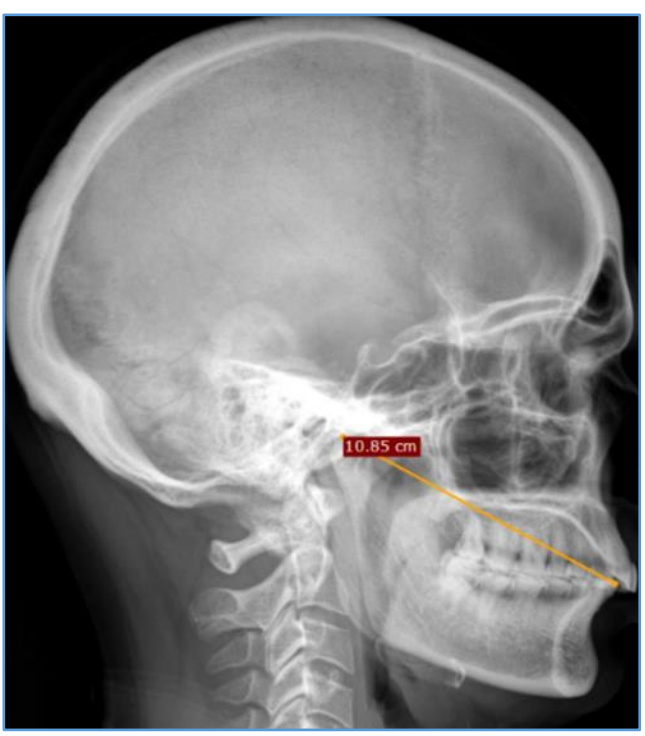

Figure 2- Effective Mandibular Depth

Anterior Depth of the Mandible[23]

It is measured from tip of the lower incisor to the lower anterior mandibular bone margin. An increase in the depth denotes significant intubation difficulty. Figure 3.

Figure 3. Anterior Mandibular Depth

Posterior Depth of the Mandible[23-24]

White and Kander (1975)[24] have shown that the posterior depth of the mandible i.e., the distance between the bony alveolus immediately behind the 3rd molar tooth and the lower border of the mandible is an important measure in determining the ease or difficulty of laryngoscopy. An increase in the depth denotes significant intubation difficulty. Figure 4.

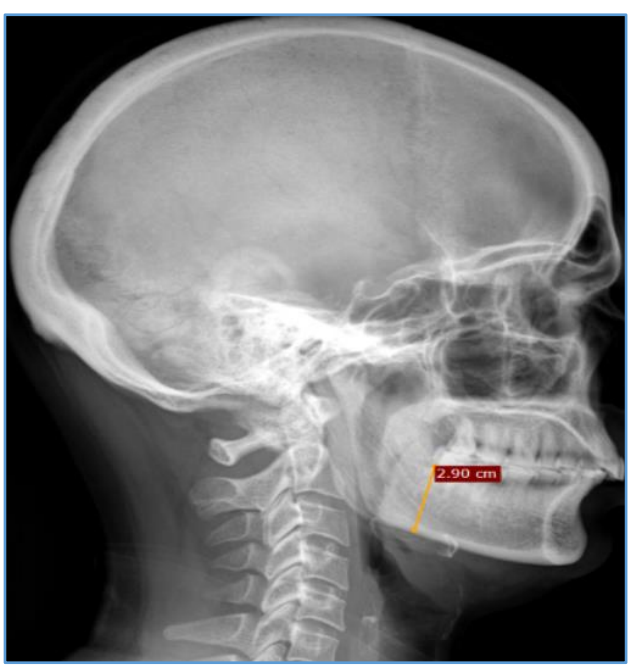

Figure 4. Posterior Mandibular Depth

C2 Spine Depth[23]

It is measured as width from the upper and the lower border of the second cervical spine. An increase in the depth denotes significant intubation difficulty. Figure 5.

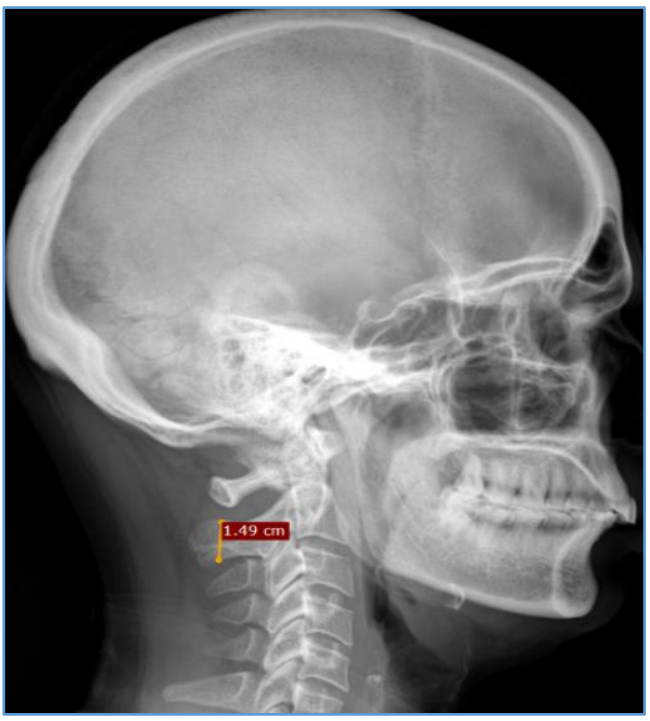

Figure 5. C_2 Spine Depth

All the radiological assessment was done by radiologist and was blinded to the study. The anaesthesiologist who performed the laryngoscopy and intubation was also blinded to the study. The glottic view was graded according to the Cormack and Lehane grading.[26] Endotracheal intubation was considered difficult, if Cormack and Lehane grading was III and IV. At the end of the surgery, patients were extubated and shifted to the post anaesthesia care unit for further monitoring.

Statistics

Statistical Analysis

The preoperative airway assessment data and the findings during intubation were used to determine the Sensitivity, Specificity, Positive and Negative predictive values for each test. Crosstabs procedure was employed for association between the airway predictors and difficulty in intubation.

Statistical Terms

- True positive: A difficult intubation that had been predicted to be difficult.
- False positive: An easy intubation that had been predicted to be difficult.
- True negative: An easy intubation that had been predicted to be easy.
- False negative: A difficult intubation that had been predicted to be easy.

Sensitivity
The percentage of correctly predicted difficult intubations as a proportion of all intubations that were truly difficult, i.e., true positives / (true positive + false negatives).

Specificity
The percentage of correctly predicted easy intubations as a proportion of all predicted difficult intubations, i.e., true negative / (true negative + false positives).

Positive Predictive Value
The percentage of correctly predicted difficult intubations as a proportion of all predicted difficult intubations, i.e., true positive / (true positive + false positives).

Negative Predictive Value
The percentage of correctly predicted easy intubations as a proportion of all predicted easy intubations, i.e., true negatives/ (true negatives + false negatives).

RESULTS

In this study, during laryngoscopy and intubation we observed 38 patients with difficulty in intubation. In Atlanto-Occipital distance vs Difficult intubation chart [table 1] shows, thirty-seven patients are true positive, ten patients are false positive, one hundred and sixty patients are true negative, and one patient is false negative.

Parameter	Value
True Positive	37
False Positive	10
True Negative	160
False Negative	1
Sensitivity	97.43%
Specificity	94.11%
PPV*	78.72%
NPV†	99.37%

Table 1. Atlanto-Occipital Distance vs Difficult Intubation; Positive Predictive Value; Negative Predictive Value

Parameter	Value
True Positive	25
False Positive	57
True Negative	114
False Negative	12
Sensitivity	67.56%
Specificity	66.66%
PPV*	30.48%
NPV†	90.47%

Table 2. Effective Mandibular Length vs Difficult Intubation; Positive Predictive Value; Negative Predictive Value

Parameter	Value
True Positive	28
False Positive	84
True Negative	88
False Negative	8
Sensitivity	77.77%
Specificity	51.16%
PPV*	25%
NPV†	91.66%

Table 3. Anterior Mandibular Depth vs Difficult Intubation;* Positive Predictive Value; †Negative Predictive Value

Parameter	Value
True Positive	16
False Positive	82
True Negative	89
False Negative	21
Sensitivity	43.24%
Specificity	52.04%
PPV*	16.32%
NPV†	80.90%

Table 4. Posterior Mandibular Depth vs Difficult Intubation; Positive Predictive Value; Negative Predictive Value

Parameter	Value
True Positive	19
False Positive	68
True Negative	101
False Negative	20
Sensitivity	48.71%
Specificity	59.76%
PPV*	21.83%
NPV†	83.47%

Table 5. C_2 Spine Depth vs Difficult Intubation;* Positive Predictive Value; †Negative Predictive Value

Radiological variables	Difficult (N=38)	Easy (n=170)	P value
Occiput- C1 spinous process cm	0.44 ± 0.12	1.03 ± 0.23	<0.01
Posterior mandibular depth cm	2.66 ± 0.38	2.55 ± 0.37	0.125
Effective mandibular length cm	10.45 ± 0.92	10.42 ± 0.83	0.853
Anterior mandibular depth cm	4.48 ± 0.47	4.45 ± 0.43	0.6369
Depth of C2	1.38 ± 0.39	1.39 ± 0.36	0.827

Table 6. Univariate Analysis of Radiological Data

The sensitivity and specificity are 97.43% and 94.11%. The PPV and NPV is 78.72% and 99.37%. In Effective Mandibular Length vs Difficult Intubation chart [table 2] shows, twenty-five patients are true positive, fifty-seven patients are false positive, one hundred and fourteen patients are true negative, and twelve patients are false negative. The sensitivity and specificity are 67.56% and 66.66%. The PPV and NPV is 30.48% and 90.47%. In Anterior Mandibular Depth vs Difficult Intubation chart [table 3] shows, twenty-eight patients are true positive, eighty-four patients are false positive, eighty-eight patients are true negative, and eight patients are false negative. The sensitivity and specificity are 77.77% and 51.16%.

The PPV and NPV is 25% and 91.66%. In Posterior Mandibular Depth vs Difficult Intubation chart [table 4] shows, sixteen patients are true positive, eighty-two patients are false positive, eighty-nine patients are true negative, and twenty-one patients are false negative. The sensitivity and specificity are 43.24% and 52.04%. The PPV and NPV is 16.32% and 80.90%. In C_2 Spine Depth vs Difficult Intubation chart [table 5] shows, nineteen patients are true positive, sixty-eight patients are false positive, one hundred and one patients are true negative, and twenty patients are false negative. The sensitivity and specificity are 48.71% and 59.76%. The PPV and NPV is 21.83% and 83.47%.

Univariate Analysis of Radiological Data

The analysis [table 6] shows only the atlanto- occipital distance has a P-value less than 0.01 and implies good predictability of difficult laryngoscopy and intubation. The other radiological predictors are of less value when compared to atlanto- occipital distance.

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. Difficult glottic view on direct laryngoscopy is the most common cause of difficult intubation. We proposed to conduct this study to compare the radiological airway assessment factors in patients undergoing surgery requiring general anaesthesia and endotracheal intubation in our hospital with regards to their Sensitivity, Specificity, Positive predictive value and Negative predictive value. Two hundred and eight patients between the ages of 25 and 65 were included in our study. The incidence of difficult intubation in our study was 14%, which is comparable to the results obtained by Frerk and Savva.[27] However, the reported incidence of difficult laryngoscopy or intubation is 1% to 15%. 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 intubation or difficult mask ventilation during our study. White and Kander[24] reported few radiological measurements which are included in this study. They reported that increase in the anterior and posterior depth of the mandible, decrease in the atlanto-occipital gap, and C_2 spine depth, determined direct laryngoscopy would be difficult. In our study only the atlanto- occipital distance have a significant relationship with prediction of difficult intubation. We could not establish statistically significant, relationship between difficulty in laryngoscopy and intubation with other radiological [Lateral X-Ray] parameters. This observation has been reported by other authors also. Bellhouse and Dore[28] also predicted difficult intubation with sensitivity of seventy seven percent with lateral X-rays. Because of the diversity of factors involved, Wilson et al[3] in his editorial, concluded that no single test would be likely to be a perfect predictor of difficult intubation.

CONCLUSION

From our study we conclude that-

1) Lateral neck radiography is useful but NOT perfect in prediction of difficult intubation.
2) Only the atlanto-occipital distance variable has significant sensitivity and specificity as a single radiological predictor of difficult intubation.
3) The other radiological predictors were unable to provide good sensitivity and were not useful in screening for prediction of difficult intubation.
4) Lateral X- ray neck may be of value in studying problem arising during difficult laryngoscopy or intubation.

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