PREOPERATIVE ASSESSMENT OF RISK FACTORS FOR DIFFICULT INTUBATION

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ABSTRACT
Objective: To determine a clinically useful variable for predicting difficult tracheal intubation in patients with seemingly normal airways.
Setting: Department of Anaesthesiology, Civil Hospital, Karachi.
Patients: A total of 150 patients requiring tracheal intubation for elective surgery.
Methodology: An airway assessment test was conducted on each patient prior to general anaesthesia, with respect to mouth opening, thyromental distance, Oropharyngeal (Mallampati) classification, neck movement, length of mandibular ramus, ability to prognath and body mass index. After induction of anaesthesia, the laryngeal view during laryngoscopy was graded and then the ability to intubate was assessed.
Results: Incidence of difficult intubation occurred in 4(2.6%) cases out of 150 patients. Airway test that were significant for predicting difficult tracheal intubation was inter-incisor distance of 3cms, Mallampati class-3, neck circumference >40cms and subluxation grade-2 with sensitivity of 100%, 3.33%, 20% and 17.64% respectively.
Conclusion: Our study concludes that inter-incisor distance of 2cms was the most sensitive predictor of difficult intubation followed by Mallampati class-3, neck circumference >40cms and subluxation grade-2.

KEYWORDS: Risk Factors, Difficult Intubation, Multivariable Analysis

INTRODUCTION

The failure to maintain a patent airway following the induction of general anaesthesia is a major concern for anaesthesiologists. For securing the airway, tracheal intubation using direct laryngoscopy remains the method of choice in most cases. However, direct laryngoscopic intubation is difficult in 1.2% of patients who have seemingly normal airways.1

The unanticipated difficult laryngoscopic intubation places patients at increased risk of complications ranging from sore throat to severe airway trauma. Moreover, in some cases the anaesthesiologist may not be able to maintain a patient’s airway, leading to serious complications such as brain damage or death.

The difficulty of achieving a patent airway varies with the anatomical and other factors in a patient. The identification of the patient with difficult airway is vital in the preoperative evaluation and planning anaesthetic management, so that endotracheal intubation and positive pressure ventilation can be achieved safely by alternative methods of tracheal intubation e.g. fibreoptic bronchoscopy.

Several clinical criteria can be routinely assessed on patients prior to anaesthesia including mouth opening (Mallampati classification), head and neck movement, ability to prognath, thyromental distance and the body weight. Accurate preoperative prediction of potential difficulty with intubation can help reduce the incidence of catastrophic complications by alerting anaesthesia personnel to take additional precautions before beginning anaesthesia and establishing an artificial airway. In addition, more accurate prediction of difficulty with intubation might reduce the frequency of unnecessary manoeuvres (e.g. awake intubation) related to false

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positive predictor is important in detection of patients at risk for difficult airway management by noting anatomical landmarks and clinical factors associated with difficult airway. However, it is still questioned whether true prediction is possible and which variables should be chosen for evaluation.\(^2\)

Although several studies have predicted a difficult airway with the use of single risk factor or risk factors used in combination i.e. multivariate analysis. The ease of laryngoscopic intubation depends on several airway elements, no single measure of airway can be expected to predict difficult intubation accurately.\(^3\)

The aim of this study was to evaluate in our setup:
1) The incidence of difficult intubation
2) The sensitivity and positive predictive value (PPV) of screening tests
3) The correlation of Cormack Lehane grade with the Mallampati score.

**PATIENTS & METHODS**

This quasi experimental study was conducted by the Department of Anaesthesiology at Civil Hospital, Karachi from September 2004 to March 2005, after obtaining approval from the Ethical Review Committee of Dow University of Health Sciences.

Informed consent was taken from 150 adult patients of either sex, scheduled to receive general anaesthesia requiring tracheal intubation for elective abdominal, urological, neurosurgery, eye, cardiac, orthopedic and ENT surgeries. Patients requiring rapid sequence intubation, with history of difficult intubation, unstable cervical spine and anatomical abnormality of head and neck were excluded from study.

Selection of the patient was done by flipping of coin. The airway was assessed pre-operatively in the pre-induction room on the day of surgery by the same anaesthetist who was involved in the anaesthetic care of the patient. The data of the patient was entered on a proforma. The information collected included patient’s age, sex, weight, height, dentition (normal or buck teeth) and airway test that could be easily completed at bed side. These tests were:

1) Test for mandibular movement
   a) “mouth opening (inter-incisor distance)” patient asked to open his/her mouth as wide as possible and the distance between upper and lower incisor was measure in the midline.
   b) “subluxation” of the mandible the patient was asked to protrude his/her lower incisor as far as possible and protrusion ranked as:
   1 - lower incisor anterior to upper incisor.
   2 - lower incisor not anterior to upper incisor.
   3 - lower incisor fails to reach to upper incisor.

2) Test for mandibular space
   a) “thyromental distance”- the patient was asked to extend the head as far as possible, keeping the mouth closed. The straight distance from inside of mentum to thyroid notch measured.
   b) “Length of mandibular ramus” - the distance between tempomandibular joint and angle of mandible measured.

3) Test for atlanto-occipital extension, the “sterno-mental distance” - the patient was asked to extend the neck and the distance between genial tubercle and sternal notch was measured.

4) Test for oropharangeal view - the Mallampati test the patient was asked to open the mouth maximally, protrude the tongue and phonate. The view thus seen is ranked into four classes:
   - Class 1 - soft palate, fauces, uvula & pillar seen.
   - Class 2 - soft palate, fauces & uvula seen.
   - Class 3 - soft palate & base of uvula seen.
   - Class 4 - soft palate not visualized.

5) BMI and neck circumference were measured.

**Method of Anaesthesia**

Patients were induced with injection thiopentone sodium 5mg/Kg, Nalbuphine 0.1mg/Kg and Atracurium 0.5mg/ Kg, and laryngoscopy was performed after three minutes. Points noted during intubation included size of blade needed, whether tracheal pressure was applied, the best view of laryngoscopy and the number of attempts.

The definition of difficult laryngoscopic intubation was based on the best laryngoscopic view and number of laryngoscopy attempts since it has been shown that using both these parameter improves the reliability of identification of difficult laryngoscopic tracheal intubation. The view at laryngoscopy was graded by Cormack Lehane in the following manner:

- Grade I - if part of vocal cord visible.
- Grade II - if only the arytenoids were visible.
- Grade III - if only epiglottis was visible.
- Grade IV - if epiglottis was not visible.

Difficult intubation in our study was defined as number of laryngoscopy attempts-grade of laryngoscopy, the score <4 or 4 was taken as easy intubation and a Score >4 as difficult intubation.

Statistical analysis was carried out using SSPS version 10. Patient’s age, weight, height and body mass index were evaluated using the student ‘t ‘ test. The sensitivity, specificity, positive and negative predictive values were
calculated according to standard formulas as follows:

\[
\text{Sensitivity} = \frac{\text{No. of difficult intubation correctly predicted}}{\text{No. of difficult intubation}}
\]

\[
\text{Specificity} = \frac{\text{No. of easy intubation correctly predicted}}{\text{No. of easy intubation}}
\]

\[
\text{+ve Predictive Value} = \frac{\text{No. of diff. intubation correctly predicted}}{\text{No. of intubation predicted to be difficult}}
\]

\[
\text{-ve Predictive Value} = \frac{\text{No. of easy intubation correctly predicted}}{\text{No. of intubation predicted to be easy}}
\]

RESULTS

A total number of 150 cases with ages ranging from 40-70 years were studied. Amongst them 68 were undergoing general surgical, 24 gynecological and 38 urological surgeries, while the remaining 24 were undergoing ENT, ophthalmological, orthopaedic, neurosurgical and cardiac surgeries.

Patients’ characteristics like sex, Mallampati scale, anatomical features, risk factors and their relation to the Cormack Lehane class shown in Table I. The incidence of difficult intubation assessed by nine variables occurred in four (2.6%) cases out of 150 (Table II). Amongst these one case was Cormack Lehane Grade II; two cases were of Grade III - one was intubated on the third attempt with the stylet and the other intubated by manipulation; and one case was of Grade IV which was intubated with help of intubating laryngeal mask.

The application of external laryngeal pressure, size of blade used and the number of attempts related to easy and difficult intubation are shown in Table I, while Fig.1 represents the sensitivity, specificity and positive predictive values of each risk factor predicting difficult endotracheal intubation. Mallampati class-3, neck circumference >40cms and subluxation grade-2 had a sensitivity of 33.33%, 20% and 17.64% respectively; only one patient with inter-incisor distance of 3cms had

<table>
<thead>
<tr>
<th>Variable</th>
<th>No. of cases</th>
<th>CL I &amp; II</th>
<th>CL III &amp; IV</th>
<th>Easy</th>
<th>Difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex - Male/Female</td>
<td>70/80</td>
<td>66/75</td>
<td>4/5</td>
<td>67/79</td>
<td>3/1</td>
</tr>
<tr>
<td>BMI &lt;30 / &gt;30</td>
<td>137/13</td>
<td>136/11</td>
<td>1/2</td>
<td>135/11</td>
<td>2/2</td>
</tr>
<tr>
<td>Dentition - Normal</td>
<td>136</td>
<td>134</td>
<td>2</td>
<td>135</td>
<td>2</td>
</tr>
<tr>
<td>Buck teeth</td>
<td>14</td>
<td>13</td>
<td>1</td>
<td>15</td>
<td>2</td>
</tr>
<tr>
<td>Inter-incisor gap</td>
<td>149</td>
<td>147</td>
<td>2</td>
<td>146</td>
<td>3</td>
</tr>
<tr>
<td>&lt;4.5cm</td>
<td>1</td>
<td>--</td>
<td>1</td>
<td>--</td>
<td>1</td>
</tr>
<tr>
<td>&gt;4.5cm</td>
<td>104</td>
<td>103</td>
<td>1</td>
<td>103</td>
<td>1</td>
</tr>
<tr>
<td>Mallampati</td>
<td>2</td>
<td>43</td>
<td>42</td>
<td>1</td>
<td>41</td>
</tr>
<tr>
<td>(4-Nil)</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Neck circumference</td>
<td>145</td>
<td>143</td>
<td>2</td>
<td>142</td>
<td>3</td>
</tr>
<tr>
<td>&lt;40cm</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>40 or &gt;40cm</td>
<td>31</td>
<td>31</td>
<td>3</td>
<td>31</td>
<td>--</td>
</tr>
<tr>
<td>Thyroment. distance</td>
<td>119</td>
<td>116</td>
<td>--</td>
<td>115</td>
<td>4</td>
</tr>
<tr>
<td>&lt;6.5cm</td>
<td>11</td>
<td>11</td>
<td>--</td>
<td>11</td>
<td>--</td>
</tr>
<tr>
<td>6.5 or &gt;6.5cm</td>
<td>139</td>
<td>136</td>
<td>3</td>
<td>135</td>
<td>4</td>
</tr>
<tr>
<td>Sternoment. distance</td>
<td>133</td>
<td>132</td>
<td>1</td>
<td>132</td>
<td>1</td>
</tr>
<tr>
<td>&lt;12cm</td>
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<td>17</td>
<td>15</td>
<td>2</td>
<td>14</td>
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<tr>
<td>12 or &gt;12cm</td>
<td>3</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Subluxation</td>
<td>100</td>
<td>99</td>
<td>1</td>
<td>98</td>
<td>2</td>
</tr>
<tr>
<td>&lt;6cm</td>
<td>50</td>
<td>48</td>
<td>2</td>
<td>48</td>
<td>2</td>
</tr>
<tr>
<td>6 or &gt;6cm</td>
<td>--</td>
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</tbody>
</table>
positioning and profound relaxation.\(^2\) When recognized before attempts at tracheal intubation, virtually all difficult airways can be secured by the selected use of specialized tracheal intubation techniques, like intubating LMA, LMA CTrach\(^1\), fibreoptic laryngoscopy and se-nascope\(^10\), although many of these methods require special training, experience, assistance and equipments.

When a difficult airway is unrecognized before attempt at tracheal intubation the result can be castrophic because the personal and equipment necessary for utilizing the specialized tracheal intubation technique may not be immediately available and the patient's spontaneous respiratory effort may have been eliminated by anaesthetics or muscle relaxant. Thus identifying patients who are likely to harbour an airway cannot reliably be secured by simple direct laryngoscopy is an important skill for all anaesthesiologist.\(^3\)

There is an extensive research data base describing historical information, physical examination findings and radiographic features that are associated with the difficult airway. Reviewed collectively, one of the most important underlying concepts suggested by this body of research literature is that the difficult airway is a product of many anatomic and pathologic variables. A rationale approach to airway assessment, therefore, naturally included detailed history, careful physical examination and inspection of relevant X-rays whenever time permits.\(^4\)

We selected nine variables for predicting difficult endo-tracheal intubation. Mallampati class-3 had a 33.33% sensitivity and 50% positive predictive value, whereas George and Jacob\(^5\) reported a 54.5% sensitivity with Mallampati. The neck circumference >40cms and subluxation grade-2 had 20% and 17.64% sensitivity respectively, additionally we found that other anatomical land-

Table III. Characteristics of Patients and Difficult Intubation according to Glotic view

<table>
<thead>
<tr>
<th>Cormack Lehane Grades</th>
<th>Intubation Easy</th>
<th>Intubation Difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>134</td>
<td>--</td>
</tr>
<tr>
<td>II</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>III</td>
<td>--</td>
<td>2</td>
</tr>
<tr>
<td>IV</td>
<td>--</td>
<td>1</td>
</tr>
</tbody>
</table>

Correlation between Cormack Lehane (CL) grade distribution with respect to Mallampati score as depicted in Fig.2. Out of the 150 patients, 104 were in Mallampati class-1; 100 patients correlated with CL grade-I, three with grade-II and one with grade-III. Forty three patients were of Mallampati class-2; 33 correlated with the CL grade-I, nine with grade-II and one with grade-IV. Three patients were of Mallampati class-3; one correlated with each CL grade-I, II and III.

**DISCUSSION**

In our study, the incidence of difficult intubation with direct laryngoscopy was 2.6% as compared to the 1.5% reported by D Cattano et al.\(^1\) Assessment of the airway and prediction of difficulty in laryngoscopy is done by most anaesthesiologist during the preoperative checkup. Anaesthetists at times encounter difficult intubation in an apparent normal individual inspite of using the best

**Fig. 1. Outcome analysis of difficult risk factors**

**Fig. 2. Correlation between Mallampati & Corineck Lane Grade**
marks and clinical risk factors were less capable of reaching a higher sensitivity. Only one patient with interincisor distance of 3 cms with 100% sensitivity predicted difficult intubation. Unfortunately the Mallampati score and all of the other anatomical and clinical indices had low sensitivity and failed in predicting poor laryngeal view, possibly because multivariate airway risk indices derived from large population samples appear to improve the positive predictive value.\(^6\)

In clinical practice there are several factors that may contribute to the lower sensitivity estimates, for example, if patients do not follow instructions appropriately or consistently or find it difficult to assess a position, reliability estimates will be lowered. To increase the reliability of the tests, patients need to have the required manoeuvres clearly described and when necessary even to have them demonstrated, asking the patients to repeat the manoeuvres until performed correctly will also help.\(^7\)

The second aspect relates to correlation of Mallampati with Cormack Lehane grade in predicting difficult endotracheal intubation, In our study one patient with CL grade-IV and Mallampati class-2 was intubated by intubating LMA. In one out of two patients in CL grade III and Mallampati class-3 was intubated with stylet, and the other was intubated by simple manipulation. One case with CL grade-II and Mallampati class-2 had difficult intubation according to our definition and was intubated with stylet on third attempt.

Although the definition of difficult intubation is related to the concept of limited laryngoscopic view, we find that laryngeal grade-III is not completely suitable to characterize difficult intubation as in one out of two patients with CL grade-III, intubation was done by simple manipulation without using an aid.

One study concluded that laryngeal grade alone is not an adequate measure of difficult intubation, but an important component of difficulty. Unfortunately, there is no generally accepted definition of difficult intubation. The American society of anaesthesiologists (ASA) has defined difficult tracheal intubation as when “proper insertion of endotracheal intubation with conventional laryngoscopy require more than three attempts, or more than ten minutes.\(^8\)

**CONCLUSION**

Though all the tests have their place, this study concludes that inter-incisor distance of 3 cms was the most sensitive predictor for difficult intubation followed by Mallampati class-3, neck circumference >40 cms and subluxation grade-2.

**REFERENCES**


