Prediction of difficult laryngoscopy in a population of Nigerian obstetric patients

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Summary

Difficulty in the maintenance of the airway during obstetric anaesthesia is a major contributory factor in anaesthetic related morbidity and mortality. There is an eightfold increase in the incidence of failed intubation in obstetrics. This is attributable to the physiological changes in pregnancy.

Eighty consecutive obstetric patients, over a one year period who required general anaesthesia for caesarian section were evaluated using five bedside tests viz: Mallampati test, Thyromental distance, Sterno-mental distance, Horizontal length of the Mandible and Inter-incisor gap.

Eight patients had difficult laryngoscopy (10%). Mallampati test had a sensitivity, specificity and positive predictive value of 87.1%, 99.6% and 70% respectively. The values obtained for the Thyro-mental distance were 62.5%, 93.1% and 50% respectively. The other tests were not able to predict intubation difficulty significantly. When all tests were combined, sensitivity, specificity and positive predictive value were values 100%, 36.1% and 14.8%. The combination of Mallampati and Thyro-mental distance had values of 100%, 93.1% and 61.5% - sensitivity, specificity and positive predictive value.

Mallampati can be used as the sole predictor of difficult intubation in Nigerian obstetric patients.

Key words. Anaesthesia, Obstetric intubation, Tracheal complication, Difficult

Résumé

Le problème dans la prise en charge des bronches pendant l’anesthésie obstétrique est un des facteurs les plus importants qui contribuent à la morbidité et mortalité ayant rapport à l’anesthésie. Il y a une augmentation à l’octuple dans les cas de l’intubation échouée dans des obstétriques. Ceci est attribuable au développement physiologique pendant la grossesse. Quatre vingt quatre patients obstétriques consécutifs, au cours d’une période d’une année, qui ont besoin de l’anesthésie générale pour la césarienne ont été évalués avec l’utilisation de cinq tests de chevet a savoir: Test Mallampati, Thyromental a distance, sterno-mental à distance, longueur horizontale de la machoirenet le vide inter-incisive.

Huit patients avaient le problème laryngoscopique soit 10%. Test Mallampati avait la sensibilité, spécificité et une valeur positive prophétique. Les autres tests ne pouvaient pas sensiblement prédire le problème lié à l’intubation. Quand on avait réuni tous les tests, les valeurs de la sensibilité, spécificité et prophétique positive étaient 100%, 36.1% et 14.8%. La combinaison de Mallampati et Thyro-mental à distance avaient des valeurs de 100%, 93.1% et 61.5% = sensibilité spécificité et la valeur positive prophétique. On peut utiliser Mallampati comme la seule prédiction de l’intubation difficile chez des patients obstétriques Nigerians.

Introduction

Difficult or failed tracheal intubation, often unexpected has been identified as the most common contributory factor to anaesthetic-related maternal death.1 2 The incidence of difficult tracheal intubation is not precisely known but failed tracheal intubation has been reported to be eight times greater in the obstetric patients when compared to other surgical patients3 4. Contributory anatomical factors among obstetric patients include laryngeal edema, large pendulous breasts and obesity. Risk factors identified at the preoperative visit have been used to alert the Anaesthesiologist so that alternative methods of securing the airway can be used or additional experienced support obtained. Although many tests have been described, the results vary from one study to another. Therefore, it has not been possible to form a judgment as to which test is the best predictor of difficult intubation.

The purpose of this study was to compare the bedside screening tests for difficult intubation described by various authors in terms of their sensitivities, specificities and positive predictive values in a sample of Nigeria Obstetrical Patients.

Materials and methods

After institutional approval by the Research and Ethics Board (REB) of the Lagos University, Teaching Hospital, 80 consecutive obstetric patients, American Society of Anaesthesiologist physical status 1 to 3 who needed general anaesthesia for caesarian section were studied. Exclusion criteria included inability to sit, gross anatomical abnormality of head and neck or recent surgery involving those areas and patients with severe cardio respiratory disorders. A senior anaesthetist with 4 years experience in the practice of anaesthesia performed the evaluation preoperatively and the various parameters were documented in a proforma for each patient.

The five bedside tests that were evaluated are - Mallampati Tests, Thyro-Mental Distance (TMD), Sterno-Mental Distance (SMD) Horizontal Length of the Mandible (HLM) and the Inter-Incisor Gap (IIG).

1. Samsoon and Young’s modification of the Mallampati Test6 was employed viz

The patient was seated with the head in the neutral position and asked to open the mouth fully and protrude the tongue maximally while the observer looked from the front at the patient’s eye level and inspected the pharyngeal
structures with a pen torch without the patient phonating. The view was graded as follows:
   i. Soft palate, uvula, faucex and pillars visible.
   ii. Soft palate, uvula (base), faucex but pillars invisible
   iii. Soft palate visible
   iv. Soft palate invisible.
   Difficulty was predicted with grades III and IV.

2. Thyro-mental distance, (Patil's Distance)*
   The patient was seated upright and asked to extend his/her head and neck as far as possible with mouth closed. The straight distance on the exterior surface from the inside of the mentum to the thyroid notch was measured.
   Difficulty was predicted when the distance was \( \leq 6.5 \text{ cm} \)

3. Horizontal Length of the mandible
   The patient was seated with the head in the neutral position. The straight distance from the angle of mandible to the symphysis-menti was measured. If the distance was less than \( 5 \text{ cm} \), intubation was anticipated to be difficult.

4. Sterno-mental Distance (Savva’s distance)*
   This distance was measured in the seated position with the head fully extended on the neck and with the mouth closed. The straight distance between the upper border of the manubrium-steri and bony point of the mentum was measured. If the distance was \( 13.5 \text{ cm} \) or less, intubation was predicted as difficult.

*Tests 2 - 4 were performed with a rigid ruler.

5. The Inter-Incisor Gap
   The patient was asked to open the mouth as wide as possible and the distance between the upper and lower incisor measured with a pair of calipers. The critical value chosen was \( 2.5 \text{ cm} \).

Induction

Induction of anaesthesia was performed in the supine position and neuromuscular blocking agent administered using a technique appropriate for the individual patient and clinical circumstance. The patient’s head was placed on a pillow in the "sniffing position" i.e. flexion of the neck and extension of the head at the atlanto-occipital joint. Repeated induction was carried out with thiopentone and suxamethonium for those patients that were difficult to intubate.

A single operator using a Macintosh #4 blade performed laryngoscopy and best view obtained (external laryngeal pressure was not applied) using the classification by Cormack and Lehane*.

   i. Vocal cords visible
   ii. Only posterior commissure or arytenoids visible
   iii. Only epiglotis visible
   iv. None of the foregoing visible.

A note was made if tracheal intubation was difficult i.e. if the view at laryngoscopy was graded Cormack-Lehane III or IV. Accuracy of each measured parameter was scored against the Cormack Lehane outcome. Values below and inclusive of each cut-off point were predicted as difficult intubation for the (Easy-to-Intubate: EIG). In the case of Mallampati Score, Mallampati I and II were predicted as easy intubation while III and IV as difficult intubation (Difficult-to-Intubate: DIG).

Confirmation of successful intubation was by bilateral auscultation over the lung fields and capnography when available.

Definitions*

The sensitivity, specificity and positive predictive value of each test was calculated as follows using Cormack Lehane Score as the constant variable.

- **Sensitivity** = the percentage of correctly predicted difficult intubation as a proportion of all intubations that were truly difficult i.e.
  
  \[
  \text{True Positives} + \text{False Negatives} 
  \]

- **Specificity** = the percentage of correctly predicted easy intubations as a proportion of intubations that were truly easy i.e.
  
  \[
  \text{True Negatives} + \text{False Positives} 
  \]

**Positive predictive value**

Value = the percentage of correctly predicted difficult intubations as a proportion of all predicted difficult intubations, i.e.

\[
\text{True positive} = \text{True positives} + \text{false positives} 
\]

The data obtained was analyzed with the aid of a computer software; statistical package for social studies (SPSS @ Inc. Chicago Illinois).

Results

A total number of 80 of the obstetric patients were studied (n = 80). Their mean age, height, weight and BMI were 30.9 ± 4.4 years; 1.6 ± 0.5m; 83.8 ± 14.6kg and 31.2 ± 5.5 respectively. Out of the 69 patients who had a Cormack-Lehane score of 1, 51 (74%) had a corresponding Mallampati 1; 15 (21.7%) had Mallampati II and 3 patients (4.3%) had Mallampati III. There was no Mallampati IV in this category (Table 1).

The mean values of the quantitative predictive tests were as follows - SMD had a mean distance of 17.8 ± 1.7 cm; TMD had a mean distance of 7.5 ± 1.6 cm; IIIG had a mean of 4.3 ± 0.6 cm and HLM a mean of 9.1 ± 0.3 cm.

**Predictive tests of easy-to-intubate (EIG) and difficult-to-intubate (DIG)**

Based on the Cormack-Lehane scores the 80 obstetric patients were sub-divided into EIG (Cormack-Lehane I and II) and DIG (Cormack-Lehane III and IV). Table II illustrates the mean values of their biodata. There was a significant difference between the means of the weight and BMI in the EIG and DIG (p = 000) - see Table II.

Table III shows the means of the predictive tests in both patient categories. A p-value of 0.01 was obtained between the EIG and DIG for Thyro-mental distance.

TMD was able to predict 5 out of the 8(62.5%) in the DIG.
Table 1 Cormack-Lehane scores of obstetrics subjects related to Mallampati assessment

<table>
<thead>
<tr>
<th>Cormack-Lehane</th>
<th>Mallampati score (Value + Row %)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 (51%)</td>
</tr>
<tr>
<td></td>
<td>2 (15%)</td>
</tr>
<tr>
<td></td>
<td>3 (3%)</td>
</tr>
<tr>
<td></td>
<td>4 (4%)</td>
</tr>
<tr>
<td>Total</td>
<td>69 (86.25%)</td>
</tr>
</tbody>
</table>

Table 2 Means of obstetric patient’s biodata grouped by Cormack-Lehane score

<table>
<thead>
<tr>
<th>Cormack-Lehane scores 1 &amp; 2</th>
<th>Cormack-Lehane Score 3 &amp; 4</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodata (n = 72)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (Years)</td>
<td>Age (Years)</td>
<td>0.907</td>
</tr>
<tr>
<td>Heigh (m)</td>
<td>Heigh (m)</td>
<td>0.398</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>Weight (kg)</td>
<td>0.000**</td>
</tr>
<tr>
<td>BMI</td>
<td>BMI</td>
<td>0.000**</td>
</tr>
</tbody>
</table>

**Statistically significant

Table 3 Means of predictive tests in obstetric subjects grouped by Cormack-Lehane score

<table>
<thead>
<tr>
<th>Predicative test</th>
<th>Cormack-Lehane scores 1 &amp; 2</th>
<th>Cormack-Lehane scores 3 &amp; 4</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stermo-Mental Distance</td>
<td>17.8 ± 1.6</td>
<td>17.2 ± 2.0</td>
<td>0.279</td>
</tr>
<tr>
<td>Thyro-Mental Distance</td>
<td>7.6 ± 1.6</td>
<td>6.6 ± 0.6</td>
<td>0.011*</td>
</tr>
<tr>
<td>Inter-Incisor Gap</td>
<td>4.3 ± 0.6</td>
<td>3.9 ± 0.6</td>
<td>0.002</td>
</tr>
<tr>
<td>Horizontal Length of Mandible</td>
<td>9.1 ± 0.3</td>
<td>9.0 ± 0.3</td>
<td>0.412</td>
</tr>
</tbody>
</table>

**Statistically significant

Table 4 Predictive trends in the parameters in Obstetric subjects

<table>
<thead>
<tr>
<th>Predictive test</th>
<th>True positive (n = 8)</th>
<th>False positive (n = 72)</th>
<th>True negative (n = 72)</th>
<th>False negative (n = 8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMD</td>
<td>5(62.5%)</td>
<td>5(6.9%)</td>
<td>67(93.1%)</td>
<td>3(37.5%)</td>
</tr>
<tr>
<td>SMD</td>
<td>0(0%)</td>
<td>0(0%)</td>
<td>72(100%)</td>
<td>8(100%)</td>
</tr>
<tr>
<td>IIG</td>
<td>0(0%)</td>
<td>0(0%)</td>
<td>72(100%)</td>
<td>8(100%)</td>
</tr>
<tr>
<td>HLM</td>
<td>4(50.0%)</td>
<td>46(63.9%)</td>
<td>26(36.1%)</td>
<td>4(50.0%)</td>
</tr>
<tr>
<td>Mallampati</td>
<td>7(87.5%)</td>
<td>3(4.2%)</td>
<td>69(95.8%)</td>
<td>1(12.5%)</td>
</tr>
</tbody>
</table>

Table 5 Test parameters in the obstetric population: sensitivity, specificity and positive predictive value

<table>
<thead>
<tr>
<th>Predictive test</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>Positive Predictive Value (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMD</td>
<td>62.5</td>
<td>93.1</td>
<td>50</td>
</tr>
<tr>
<td>SMD</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>IIG</td>
<td>0</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>HLM</td>
<td>50</td>
<td>36.1</td>
<td>7.7</td>
</tr>
<tr>
<td>Mallampati</td>
<td>87.5</td>
<td>95.8</td>
<td>70</td>
</tr>
</tbody>
</table>

Discussion

A screening test for the prediction of difficult laryngoscopy must be rapid and provide reliable results. No single screening test is 100% sensitive and 100% specific. A test to predict difficult laryngoscopy should have a high positive predictive value, so that only a few patients with airways actually easy to intubate are subjected to the protocol for management of a difficult airway. Inevitably some difficult laryngoscopies are not predicted and also false positives occur, but they must be as few as possible.

Difficult laryngoscopy was defined by the ASA task force as occurring when “it is not possible to visualize any part of the vocal cords with conventional laryngoscopy.” This would equate to grade III or IV laryngoscopy of the Cormack-Lehane classification.

The five tests used in this study included Mallampati test, Stermo-Mental distance, Thyro-Mental distance, the Horizontal length of the Mandible and the Inter-incisor gap. The Mallampati test has often been criticized for it’s low sensitivity and specificity. Lack of reproducibility due to interobserver variation has been another problem noted by a lot of our colleagues. We found this test very useful amongst our obstetric patients after carefully carrying out the test described by Mallampati. Provided the patient is not gagging or phonating, the view should be constant and a clearly defined grading system should make the tests reproducible. Careful methodology would explain the sensitivity, specificity

while falsely predicting 46(63.9%). SMD and IIG however had no predictive values. See Table IV.

The sensitivity, specificity and the positive predictive value of the test parameters were calculated. (Table V). Mallampati had the highest values: 87.5%; 95.8% and 70% respectively. Next were the values obtained by the TMD, which were 62.5%; 93.1% and 50%. HLM had values of 50%; 36.1% and 7.7%. When all the tests were combined, all the cases in the DIG were predicted. The five-test combination however falsely predicted 46 (63.9%). The combination of Mallampati and TMD also predicted all the cases in the DIG while falsely predicting 5(6.9%) cases.

The combined sensitivity of all the tests was 100%, while the specificity was 36.1% and the positive predictive value was 14.8%. The combination of Mallampati and TMD had a sensitivity of 100%; specificity 93.1% and positive predictive value of 61.5%. (Table VI).
and positive predictive value of 87.5%, 95.8% and 70%
respectively, which is comparable with the work done by
Mallampati et al in an American population and Ita, Eshiet
and Akpan in Calabar, Nigeria. Frerk had a sensitivity of
81.2% and specificity 81.5% which could be compared to the
results in this study.6

The Sterno-mental distance could not predict any of the
difficult laryngoscopies. This could be attributed to the cut-off
point of 13.5cm, which was used in this study. Savva1
who first used the test to predict difficult laryngoscopy and
intubation used a distance of 12.5cm. Ramadhani and
colleagues subjected the cut off point to discriminate
analysis and they used a distance of 13.5cm, as their cut-off
point. The mean distance of the EIG was 18.5± 2.1cm while
the mean distance in the DIG was 17.1 ± 1.9cm. A possible
cause of these differences in mean values could be attributed
to anthropometrical differences between people from the
Middle East and West Africa. It is hoped that further research
should shed more light on this observation. Although the
cut-off point for the Thyro-mental distance was 6.5cm, it was
found to be useful in the prediction of the difficult
laryngoscopies. The differences in the means between the
DIG (6.6 ± 0.6cm) and the EIG (7.6 ± 1.6) were statistically
significant (p = 0.011). This might be another pointer that
anthropometrical differences may have a role to play. Weight
contributed to the prediction of difficult laryngoscopy. The
differences between the means of the DIG (10.9 ± 12.4kg)
and the EIG (81 ± 12.0kg) were statistically significant (p =
0.000). The Inter-incisor gap and the horizontal length of the
mandible were not found useful in the prediction of the difficult
laryngoscopies. When all the tests were combined, all the
difficult laryngoscopies were predicted but at the expense of
a very low specificity (36.1%) and positive predictive value
(14.8%). When the Mallampati test and the Thyro-mental
distance were combined 100% sensitivity was achieved but
the specificity dropped to 93.1% and the positive predictive
value dropped to 61.5% from 70%. Perhaps a larger sample
size could have made a difference in the results obtained.
In conclusion we find a strong correlation between the
Mallampati test and prediction of difficult laryngoscopy. The
advantage of this method is that it can easily be performed at
the bedside. It is always better to be prepared for difficulty
beforehand than be caught in unexpected difficulty.

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