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ORIGINAL ARTICLE

Diagnostic Accuracy of Auscultation During General Anesthesia by Taking Fiberoptic Bronchoscopy as Gold Standard

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ABSTRACT

Objective: To evaluate the diagnostic accuracy of auscultation in the detection of inappropriate positioning of endotracheal tube, in patients undergoing elective surgeries, by taking fiberoptic bronchoscopy as gold standard.
Study design: cross sectional study
Place and duration: Department of anesthesia, Nishtar Hospital, Multan
Methodology: A total of 205 patients admitted in general surgery ward were included in the study. The pre-operative assessment was done one day before surgery. The level of difficulty of intubation was assessed during pre-operative assessment. SPSS version 23 was used for data analysis. Tests of significance chi square and t-test were applied. P-value < 0.05 was taken as statistically significant.
Results: Therefore, the estimated sensitivity was 72.03%. The estimated specificity was 65.6%. Positive predictive value was 73.9% and negative predictive value was 63.3%. Two hundred and five patients were included in this study of both genders. Gender distribution revealed as n=144 (70.2%) males and n=61 (29.8%) females. The mean age of the patients was 38.92±10.61years. ASA status I and II observed as n=121 (59.0%) and n=84 (41.0%), respectively. Mallampati grading I and II observed as n=127 (62.0%) and n=78 (38.0%), respectively. Laryngoscopy grading I and II observed as n=135 (65.9%) and n=70 (34.1%), respectively.
Practical Implication: The main objective of this study was to evaluate the relative diagnostic accuracy of auscultation during GA. Therefore, we evaluated each technique's sensitivity, specificity, (PPV), (NPV) and overall accuracy in detecting incorrect endotracheal tube positioning.
Conclusion: The five point auscultation technique is a reliable method of confirmation of endotracheal intubation, as verified by flexible fiberoptic bronchoscope.
Keywords: Auscultation, Fiberoptic bronchoscopy, General analgesia, Diagnostic accuracy, sensitivity.

INTRODUCTION

Endotracheal tube insertion is a commonly used and safe procedure, as long as it is performed by a qualified medical practitioner[1]. However, due to the potential for serious complications, it is important to ensure that the tube is properly placed and that a confirmatory procedure is performed to exclude any potential misplacement of the tube and the associated risks[2]. The risks associated with an improper placement of the endotracheal tube can include hypoxemia, regurgitation, aspiration, and even cardiac dysrhythmias and death[3].

Auscultation has long been a standard method for confirming endotracheal tube (ETT) positioning, with five points on the chest and abdomen being ausculted, two sites on each side of the chest and one in the epigastric region of the abdomen[4]. Unfortunately, this method is burdened by low accuracy due to a noisy environment, the possibility of referred sounds, and misinterpretations[5]. This unreliability of standard auscultation has led to the development of other methods, the most commonly documented being equal lung sounds followed by visualization of the vocal cords[6].

However, anatomical irregularities such as a large tongue, prominent incisors, and a short neck may make visualization of the ETT position within the glottis difficult. In addition, blood and secretions may also prevent visualization of the vocal cords[7]. Bronchoscopic confirmation of endotracheal tube (ETT) placement has been widely accepted as an effective and safe method for confirming appropriate ETT positioning[8]. Fiberoptic bronchoscopy (FOB) offers a minimally invasive technique that can be used to evaluate tracheal rings and carina and ensure appropriate ETT placement in a range of clinical scenarios, including where there is a particular need for confirmation due to morbid obesity[9].

The presence of bronchoscopy in the operating theatre provides an additional layer of safety for patients in these complex cases, and can be used both to confirm ETT placement and to guide the insertion of tubes and devices. Studies have demonstrated that FOB is a reliable and accurate method of confirming correct ETT placement, with few false-negative results[10].

METHODOLOGY

Study Design: It was a cross sectional study.
Study Setting & Duration: It was conducted at anesthesia department of nishtar hospital Multan from December 2021 to November 2022 in one year duration.
Sample Size: The sample size for specificity of auscultation method taken as 80% and the maximum marginal error rate of 0.05 is calculated by use of following formula: $FP + TN = Z^2 \times (Sp(1-Sp)) / W^2$, $N = (FP+TN) / 1 - P$, where Sp is the specificity of the test and W is the maximum marginal error rate and P is the prevalence. The prevalence of inappropriate position is taken as 18% from previous studies and literature review [7]. We estimate a sample size of 299 intubations.
Inclusion Criteria: Patients with ages 18 and above both male and female patients, type of surgery: general / Elective surgery, ASA Grade: ASA I &II were included.
Exclusion Criteria: Inadequate facemask or laryngeal mask ventilation, patients with massive airway bleeding, patients with upper airway obstruction, risk for regurgitation or vomiting, patients with infectious diseases like Hepatitis B&C and HIV were excluded.

METHODOLOGY

After approval from ethical committee 299 patients were selected from the patients admitted for general surgery in Nishtar hospital, Multan. The pre-operative assessment was done one day before surgery. After written informed consent demographic data (name, age, gender); type of surgery; and ASA status was recorded. On the operative day, on the arrival of the patient on operating table, standard monitoring in the form of non-invasive blood pressure

monitoring, pulse, ECG and oximetry were attached to the patient and baseline values were recorded. The patients were from age group 18 years and above of age and from elective situations. The level of difficulty of intubation was assessed during pre-operative assessment. The patients were pre-medicated with Midazolam 0.01-0.02 mg/ kg body weight. Standard airway and emergency equipment were available. After induction with Propofol 1.5-2.5 mg/kg body weight and neuromuscular paralysis with Atracurium 0.5 mg/ kg body weight. The patient was ventilated with a mixture of 33% N2O and 66% O2 with Isoflurane 1.15 MAC. The laryngoscopy was performed with MacIntosh blade no. 3 or 4 and patient was intubated with endotracheal tube with Murphy eye size no. 6.5 or 7.0 for women and 7.0 or 7.5 for men under direct visualization of glottis and vocal cords. The ETT was connected to circuit and the endotracheal tube was secured with tape at appropriate length with tape at corner of mouth after confirmation of bilateral equal vesicular breath sounds with auscultation. The correct placement of ETT was confirmed by auscultation with stethoscope first at the apices of lungs and both axillae near mid axillary lines bilaterally and in the epigastrium with manual ventilation. After the ETT is secured the circuit was disconnected and a flexible fiberoptic bronchoscope was passed through the lumen of ETT and advanced till the visualization of carina (bifurcation of trachea). The tube was reinserted by fiberoptic bronchoscope, if found to be esophageal; or readjusted if found to be endobronchial upon fiberoptic bronchoscopy. Finally the ETT was connected to a circuit for ventilation.

The placement of ETT in trachea above carina (bifurcation of trachea) was labeled as appropriate placement of ETT. Inappropriate placement of ETT was the placement of ETT anywhere other than trachea, includes esophageal intubation and endobronchial intubation. Esophageal intubation was the accidental (un-intentional) placement of ETT in esophagus. Endobranchial intubation was the placement / sliding of ETT in a main bronchus (usually right), hampering optimal oxygenation of lungs. Difficult intubation is defined as either a direct laryngoscopy Cormack or Lehane grade 3 or 4 unsuccessful intubation attempts by a trained anesthetist.

Mallampatti scoring is method of predicting the difficult airway for intubation in sitting position with mouth opened to full extent where

i) Class 1: visualization of facial pillars, soft palate and uvula
ii) Class 2: visualization of facial pillars and soft palate
iii) Class 3: visualization of only soft palate
iv) Class 4: soft palate not visible

Laryngoscopic Grading is method of predicting the difficult airway for intubation by direct laryngoscopy in paralyzed patient where

i) Grade I: visualization of full glottis including full vocal cords and epiglottis
ii) Grade II: visualization of epiglottis and posterior one-third of vocal cords
iii) Grade III: visualization of epiglottis only.
iv) Grade IV: visualization of tip of epiglottis only

Definitions of Parameters: True positives defined as those patients in whom ETT found to be placed in inappropriate position on auscultation and also found to be placed inappropriately on fiberoptic bronchoscopy.

True negatives defined as those patients in whom ETT found to be in endotracheal position on auscultation and also endotracheal on fiberoptic bronchoscopy.

False positives and defined as inappropriate positioning of ETT on auscultation but endotracheal positioning on fiberoptic bronchoscopy.

False negatives defined as endotracheal position on auscultation and found to be inappropriate positioning on fiberoptic bronchoscopy

Data Analysis: All the data from 299 consecutive patients were entered and analyzed using SPSS version 21.0. The sensitivity, specificity , positive and negative predictive value of the test was calculated using standard protocols against the gold standard of fiberoptic intubation.

RESULTS

Two hundred and five patients were included in this study of both genders. Gender distribution revealed as n=144 (70.2%) males and n=61 (29.8%) females. The mean age of the patients was 38.92±10.61years. ASA status I and II observed as n=121 (59.0%) and n=84 (41.0%), respectively. Mallampati grading I and II observed as n=127 (62.0%) and n=78 (38.0%), respectively. Laryngoscopy grading I and II observed as n=135 (65.9%) and n=70 (34.1%), respectively. Type of surgery such as general and elective noted as n=116 (56.6%) and n=89 (43.4%), respectively. Endobronchial intubation on auscultation positive in n=115 (56.1%) patients and negative in n=90 (43.9%) patients. While, endobronchial intubation on F.O.B positive in n=118 (57.6%) patients and negative in n=87 (42.4%) patients (Table-1).

It was observed that 85 patients with endobronchial intubation on auscultation as well as onendobronchial intubation on F.O.B, known as true positive. 30 patients with endobronchial intubation on F.O.B but absent on endobronchial intubation on auscultation, known as false positive. 33 patients had endobronchial intubation on F.O.B but absent auscultation, labeled as false negative. 57 patients had no endobronchial intubation on F.O.B and also absent on auscultation, labeled as truenegative.The difference was statistically significant (p=0.000) Table-2. Therefore, the estimated sensitivity was 72.03%. The estimated specificity was 65.6%. Positive predictive value was 73.9% and negative predictive value was 63.3% Table-3.

Table-1: Demographics and some clinical values

Characteristics	Frequency (%)
Gender	
Male	144 (70.2%)
Female	61 (29.8%)
Age	38.92±10.61
ASA	
I	121 (59%)
II	84 (41%)
Mallampati grading	
I	127 (62%)
II	78 (38%)
Laryngoscopy grading	
I	135 (65.9%)
II	70 (14.1%)
Type of Surgery	
General	116 (56.6%)
Elective	89 (43.4%
Endobronchial intubation on auscultation	
Positive	115 (56.1%)
Negative	90 (43.9%)
Endobronchial intubation on F.O.B	
Positive	118 (57.6%)
Negative	87 (42.4%)

Table-2: Comparison of endobronchial intubation on auscultation and endobronchial intubation on F.O.B

Intubation on auscultation	Intubation on F.O.B		Total	p-value
	Positive	Negative		
Positive	True positive 85	False positive 30	115	0.000
Negative	False Negative 33	True negative 57	90	

Table-3: Diagnostic Accuracy

Diagnostic Measures	Value
Sensitivity	72.03%
Specificity	65.6%
Positive Predictive Value (PPV)	73.9%
Negative Predictive Value (NPV)	63.3%

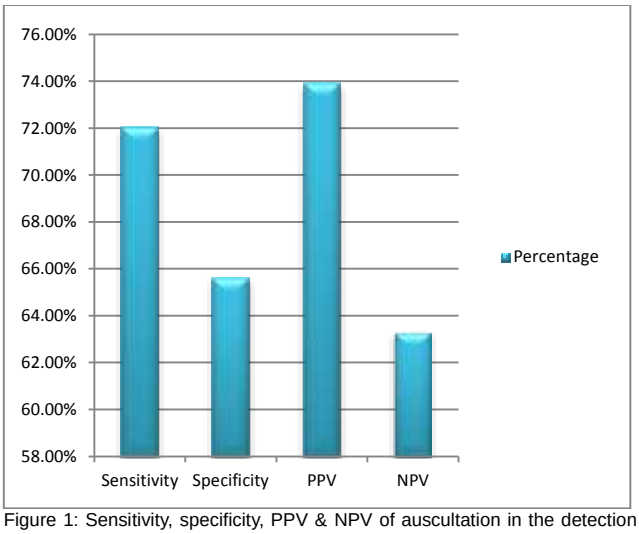

Figure 1: Sensitivity, specificity, PPV & NPV of auscultation in the detection of inappropriate positioning of endotracheal tube

DISCUSSION

Airway protection and mechanical ventilation are essential for successful intubation, and the proper positioning of an endotracheal tube (ETT) within the airway is key in achieving optimal outcomes[11]. There are several methods used to verify the correct placement of an endotracheal tube or ETT. Some common methods are palpation of chest, observation and direct visualization of tracheal areas, capnography flexible bronchoscopy and chest radiography[12].

Furthermore, the authors of the study conducted by Sugiyama et al[13] emphasized the importance of chest auscultation and the need for additional methods to be used in the diagnosis of endobronchial intubation. Endotracheal tubes (ETTs) with a Murphy eye are commonly used in pediatric patients to facilitate ventilation and allow bilateral breath sound auscultation. However, reliability of chest auscultation can be reduced by detecting endobronchial intubation[14]. Through Murphy eye sign bilateral passage of air can be detected. It is recommended for physicians to be aware of the limitations of Murphy eyes and use additional diagnostic tools to accurately diagnose mainstem intubation[14].

In a study of 188 intubations by Evron et al[15], an analysis of fluoroscopy and fiberoptic bronchoscopy (FOB) revealed that both techniques had their strengths in detecting an incorrectly placed endotracheal tube (ETT). Auscultation, the traditional technique for intubation verification, was found to be inadequate for detecting all cases of accidental intubation in the right mainstem bronchus. Fluoroscopy was able to detect 11.8% of these cases, while FOB was able to detect a higher percentage of cases at 5 events. Even in cases where the ETT tip was located one centimeter away or less from the carina, auscultation was only able to identify 3 of the 6 cases detected by FOB[16].

Accidental bronchial intubation is a major concern in endotracheal intubation procedures, as it can lead to serious adverse events. Previous studies[17] have demonstrated the effectiveness of a topographic measurement method in reducing the risk of accidental bronchial intubation. However, this method may only provide assurance of correct ETT position immediately after intubation. In a study by Wu et al[18] have found that operating table repositioning, patient movement, and abdominal insufflation with CO2 in laparoscopic procedures may further move the ETT, placing the tip into the bronchus. In the present study, all patients with accidental bronchial intubation were women.

It is clear that the findings of Chong et al[19] demonstrate that the 21-23 cm insertion method have no dangerous or accidental intubation in bronchial sites. This suggests that there is no need to use any additional strategies to guard against bronchial intubation when using this technique. Therefore, it is important to consider the effects of patient height and tracheal length when selecting the ETT insertion technique. Ultimately, further research is needed to further understand the risks associated with different ETT insertion methods[20].

CONCLUSION

The five point auscultation technique is a reliable method of confirmation of endotracheal intubation, as verified by flexible fiberoptic bronchoscope.

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