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CONFIRMATION OF ENDOTRACHEAL TUBE POSITION BY AIRWAY UTLTRASOUND IN EMERGENCY DEPARTMENT

Medicine

Dr. Shahbazia Department of Emergency Medicine, Peerless Hospital And B.K. Roy Research Centre, Kolkata

Dr. Indraneel Dasgupta* Department of Emergency Medicine, Peerless Hospital And B.K. Roy Research Centre, Kolkata *Corresponding Author

Dr. Amit Bhowmik Department of Emergency Medicine, Peerless Hospital And B.K. Roy Research Centre, Kolkata

Dr. Debarshi Jana Institute of Post-graduate Medical Education and Research, A.J.C. Bose Road, Kolkata.

ABSTRACT

We compared the sensitivity and specificity of Sonographic confirmation of correct endotracheal tube position of verifying correct placement of the endotracheal tube.

We conducted a prospective observational study in the Department of Emergency Medicine and Intensive Care units of Peerless Hospital and B.K. Roy Research Centre, Kolkata from July 2018 to December 2019. 121 patients undergoing emergency intubations during the study period was recruited for the study after taking required consent.

It was found that ET tube visualized in trachea in transverse view by ultrasound showed that Sensitivity was 99.1%, Specificity was 100.0%, Positive Predictive Value was 100.0%, Negative Predictive Value was 80.0 and Accuracy was 99.17%. Our study showed that ET tube visualized trachea in horizontal view by ultrasound showed that Sensitivity was 98.3%, Specificity was 100.0%, Positive Predictive Value was 100.0%, Negative Predictive Value was 66.7 and Accuracy was 98.34%.

We can inculcate using point of care ultrasound in endotracheal confirmation by emergency physicians.

KEYWORDS

INTRODUCTION

Endotracheal intubation is a routine emergency procedure in Emergency Medicine practice. The procedure is performed by many clinicians with different levels of experience in airway management. Although Emergency Endotracheal intubation may be a life saving procedure, proper positioning of endotracheal tube in the trachea is necessary for adequate airway patency. Malpositioning of endotracheal tube causes a serious life threat to the intubated patient.

So, it is important to confirm proper placement of the endotracheal tube (ETT) as there is significant morbidity and mortality associated with inadvertent oesophageal intubation [1-3]. Endotracheal intubation is a frequently performed procedure in an emergency medicine department and an Emergency Physician has to be adept at performing intubation and confirming ETT position [4]. An ideal technique to confirm the position of ETT is one that provides verification of tracheal location of the ETT at a level above the carina to ensure bilateral ventilation. The 2010 American Heart Association (AHA) and the European Resuscitation Council guidelines recommend the use of both clinical assessments like bilateral auscultation of the chest and confirmation devices to verify ETT placement[4-5].

Numerous studies have compared methods used for distinguishing between endotracheal and esophageal placement of the tube. Visual confirmation during laryngoscopy, expansion of the chest wall during ventilation, auscultatory method, capnography, and chest X-ray are modalities currently used in practice. These techniques vary in their degree of accuracy.[6,7,8,9]

Capnography is freely available in operation theaters but not in many emergency departments (Eds). Ultrasound, on the contrary, is emerging in most EDs as it is used in point of care imaging for trauma as well for guided interventions.[10] Ultrasound machine is portable, noninvasive, and the images are easily reproducible.[11] Various studies have shown that ultrasound is a potential method to confirm proper ETT placement.[12-18]

We compared the sensitivity and specificity of Sonographic confirmation of correct endotracheal tube position of verifying correct placement of the endotracheal tube. Further, the author also aims to determine whether sensitivity and specificity of this Sonographic method would increase as a function of the Doctor's experience.

METHODOLOGY

We conducted a prospective observational study in the Department of Emergency Medicine and Intensive Care units of Peerless Hospital and B.K. Roy Research Centre, Kolkata. The duration of the study was approximately 1½ year starting from July 2018 to December 2019. Written informed consent of the patients or relatives was obtained before the study.

Inclusion Criteria:

1. Adults (age >18 years).
2. Patients who are intubated in Department of Emergency Medicine and Intensive Care units of Peerless Hospital.

Exclusion Criteria:

1. Age < 18 years.
2. Patients who are intubated from outside before coming to this hospital.
3. Patients with subcutaneous emphysema, pneumothorax, a history of pneumonectomy and pleurodesis. (Sonographic imaging for pleural sliding is not technically feasible in these patients, as the ultrasound waves tend to reflect strongly wherever air meets tissue secondary to high acoustic impedance).

Study Design:

For the purpose of the study 121 patients undergoing emergency intubations during the study period was recruited for the study after taking required consent. After the trachea has been intubated by using conventional direct laryngoscopy with a standard endotracheal tube the resident/registrar doctor or the consultant or PGT/PDT or MO/RMO, who did the procedure was wrote their opinion regarding the Endotracheal tube placement as per the standard confirmatory methods in the sequentially numbered form provided.

Following this, a post intubation an airway Ultrasound examination (as per standard POCUS protocol) was performed by an emergency physician / ITU Doctor, who is not involved in clinical management of the patient and blinded to the result of the standard confirmatory methods of endotracheal tube placement. Our findings regarding the following were recorded in the second part of the forms:

1. Position of the tube: endooesophagus, endobronchial or endotracheal

2. Depth of tube insertion
3. Bilateral air entry of air in lung US

The intubater clinically confirmed the intubation using direct visualization of et tube passing the vocal chord , 5 point auscultation which involves listening to the breath sound in the upper and lower chests bilaterally and over epigastrium with each artificial breath given , and pulse oximetry suggestive of adequate oxygenation .ET CO2 was not used in this study .

These forms were kept in the Emergency Department and ITU/ ICU complex in sealed opaque numbered envelopes which was opened only after the procedure. Each envelope was contain 2 instruction forms: in one of the forms, the operator had comment based on the traditional methods and in the second form, the doctor doing the POCUS airway ultrasound was comment based on the US findings. The participant was also mention whether he was more comfortable with used or POCUS airway ultrasound and mark the level of difficulty while performing the procedure on a 10 point Likert scale. The forms were then retained in the envelope and resealed to be collected by the author(s) for data analysis. Training on POCUS airway intubation ultrasound by a consultant Radiologist was organised for all the ITU and Emergency Department doctors who were interested to take part in this study, prior to data collection for this study.

Statistical Analysis:
For statistical analysis data were entered into a Microsoft excel spreadsheet and then analyzed by SPSS (version 25.0; SPSS Inc., Chicago, IL, USA) and GraphPad Prism version 5. Data had been summarized as mean and standard deviation for numerical variables and count and percentages for categorical variables.

Z-test (Standard Normal Deviate) was used to test the significant difference of proportions. p-value ≤ 0.05 was considered for statistically significant.

RESULT AND ANALYSIS

Our study showed that 5(4.1%) doctors were ≤30 years old, 17(14.0%) doctors were 31-40 years old, 29(24.0%) doctors were 41-50 years old, 34(28.1%) doctors were 51-60 years old and 36(29.8%) doctors were 61-70 years old. The value of z is 0.2835. The value of p is .77948. The result is not significant at p < .05. 82(67.8%) doctors were female and 39(32.2%) doctors were male. The value of z is 5.5283. The value of p is < .00001. The result is significant at p < .05.

We found that 5(4.15%) doctors were Consultant, 98(81.0%) doctors were PGT and 18(14.9%) doctors were under Registrar Category. The value of z is 10.294. The value of p is < .00001. The result is significant at p < .05.2(1.7%) doctors had 1 year of experience, 29(24.0%) doctors had 2 years of experience, 28(23.1%) doctors had 3 years of experience, 29(24.0%) doctors had 4 years of experience, 25(20.7%) doctors had 5 years of experience, 3(2.5%) doctors had 6 years of experience, 2(1.7%) doctors had 10 years of experience and 3(2.5%) doctors had 12 years of experience. The value of z is 0.1515. The value of p is .88076. The result is not significant at p < .05.

In our study 116(95.9%) doctors had ET tube visualized trachea (transverse view). The value of z is 14.2707. The value of p is < .00001. The result is significant at p < .05. 115(95.0%) doctors had ET tube visualized trachea (horizontal view). The value of z is 14.0136. The value of p is < .00001. The result is significant at p < .05. 14(11.6%) doctors had Identification ET tube cuff at suprasternal notch. The value of z is 11.9565. The value of p is < .00001. The result is significant at p < .05. 119(98.3%) doctors had Identification esophagus at the level of 2nd / 3rd tracheal ring. The value of z is 15.0421. The value of p is < .00001. The result is significant at p < .05.

We showed that 5(4.1%) doctors had an Opinion about Endo Esophageal, 112(92.6%) doctors had an opinion about Endo tracheal and 4(3.3%) doctors had an opinion about End bronchial. The value of z is 15.0421. The value of p is < .00001. The result is significant at p < .05. 116(95.9%) doctors were confident with USS DIAGNOSIS. The value of z is 14.2707. The value of p is < .00001. The result is significant at p < .05.

Our study showed that 23(19.0%) doctors had 7 Level of confidence scale of 1 to 10, 14(11.6%) doctors had 8 Level of confidence scale of 1 to 10, 52(43.0%) doctors had 9 Level of confidence scale of 1 to 10 and 32(26.4%) doctors had 10 Level of confidence scale of 1 to 10. The value of z is 2.7007. The value of p is .00694. The result is significant at p < .05. 117(96.7%) patients had ET tube visualized in Clinical Finding. The value of z is 14.5278. The value of p is < .00001. The result is significant at p < .05.

In our study USG, 115(98.3%) doctors had ET tube visualized trachea horizontal view. Association of ET tube visualized trachea horizontal view vs. Clinical Finding was statistically significant (p <0.0001). 115(95.0%) patients had true positive, 4(3.3%) patients had true negative, no patient had false positive and 2(1.7%) patients had false negative. In USG, 116(99.1%) doctors had ET tube visualized trachea transverse view. Association of ET tube visualized trachea transverse view vs. Clinical Finding was statistically significant (p <0.0001).

We found that 116(95.8%) patients had true positive, 4(3.4%) patients had true negative, no patient had false positive and 1(0.8%) patient had false negative. The mean Years of experience (mean± s.d.) of doctors were 3.7934 ± 1.9533 Years. The mean level of confidence scale of 1 to 10 (mean± s.d.) of doctors was 8.7686 ± 1.0469. In ET tube visualized trachea horizontal view, the mean Years of experience (mean± s.d.) of doctors was 3.9043 ± 1.9375 Year. The difference of mean Years of experience: ET tube visualized trachea horizontal view was statistically significant (p=0.0057). In ET tube visualized trachea transverse view, the mean Years of experience (mean± s.d.) of doctors was 3.8879± 1.9371 Years. The difference of mean Years of experience: ET tube visualized trachea transverse view was statistically significant (p=0.0098).

DISCUSSION

Our study showed that the mean Age (mean± s.d.) of doctors was 3.6529 ± 1.1670 Years.

Our study showed that 5(4.15%) doctors were Consultant, 98(81.0%) doctors were PGT and 18(14.9%) doctors were under Registrar Category. We found that the mean Years of experience (mean± s.d.) of doctors were 3.7934 ± 1.9533 Years.

It was found that 116(95.9%) doctors had ET tube visualized trachea (transverse view).

Our study showed that 115(95.0%) doctors had ET tube visualized trachea (horizontal view).

It was found that 14(11.6%) doctors had Identification ET tube cuff at suprasternal notch.

Our study showed that 119(98.3%) doctors had Identification esophagus at the level of 2nd / 3rd tracheal ring.

We found that 5(4.1%) doctors had an Opinion about Endo Esophageal, 112(92.6%) doctors had an opinion about Endo tracheal and 4(3.3%) doctors had an opinion about End bronchial.

It was found that 116(95.9%) doctors were confident with USS DIAGNOSIS.

We found that 23(19.0%) doctors had 7 Level of confidence scale of 1 to 10, 14(11.6%) doctors had 8 Level of confidence scale of 1 to 10, 52(43.0%) doctors had 9 Level of confidence scale of 1 to 10 and 32(26.4%) doctors had 10 Level of confidence scale of 1 to 10. It was found that the mean level of confidence scale of 1 to 10 (mean± s.d.) of doctors was 8.7686 ± 1.0469.

Our study showed that 117(96.7%) patients had ET tube visualized in Clinical Finding.

Galicinao J et al [19] (2007) showed that during phase II, the mean times to acquire bedside ultrasonographic images of the endotracheal tube through the cricothyroid membrane and to obtain a chest radiograph were 17.1 seconds and 14.0 minutes, respectively. In 3 cases, bedside ultrasonographic images proved to be invaluable when the colorimetric end-tidal carbon dioxide detector yielded false-negative or equivocal readings. Bedside ultrasonography can be used to accurately and rapidly determine the presence of the endotracheal tube within the trachea in pediatric patients.

Shebl E et al [20] (2019) found that 120 were men and 80 were women

with a mean age was 49.1±12.4 years. Results of the 200 patients studied, 177 patients had confirmed ETT in the trachea by both capnography and tracheal ultrasonography; seven patients had confirmed ETT in the trachea by capnography only, and 16 patients had ETT outside the trachea by both capnography and tracheal ultrasonography. The sensitivity and specificity tracheal ultrasound were 96.2 and 100%, respectively. The time (s) needed to confirm the ETT position by clinical assessment, tracheal ultrasonography.

Patil V et al [21] (2019) found that they performed airway ultrasonography real time during intubation and detected ETT placement by loss of snow storm sign. Tracheal placement was also confirmed by capnography. They used saline filled cuff method to place ETT cuff depth at 3rd and 4th tracheal ring and confirmed the appropriateness of the ETT depth on chest X-ray. They calculated the sensitivity and specificity of this technique. They included 89 patients for the study. The ultrasound detection of the placement of the tube with the loss of snow storm sign was seen in 86 patients. The incidence of esophageal intubations was 2.0%.

Gottlieb M et al [22] (2018) found that transtracheal sonography is rapid to perform, with an acceptable degree of sensitivity and specificity for the confirmation of endotracheal intubation. Ultrasonography is a valuable adjunct and should be considered when quantitative capnography is unavailable or unreliable.

TOLU KENDIR OZ et al [23] (2019) found that the double-line appearance could not be obtained from one patient only when using transcricoid ultrasonography, but the bilateral pleural shift movement was observed among all the cases by using pulmonary ultrasonography (sensitive: 98%-100%). The determination of endoesophageal, endotracheal and endobronchial intubations can be easily made by using transcricoid and pulmonary ultrasonography. The use of ultrasonography may significantly contribute to critical airway management as fast, accurate and on time.

Rahmani F et al [24] (2017) found that an emergency medicine performed real-time sonography of the trachea to evaluate the correct placement of endotracheal tube. Tube passage (snowstorm) and vocal cord angel widening (bullet sign) were evaluated, and then both lungs sliding and diaphragm movement were evaluated to confirm correct tube placement and ventilation. In this study, 75 patients entered the study.

Goodman LR et al [25] (1976) found that a malpositioned endotracheal tube is a potential hazard to the intubated patient. Ideally, the tube tip should be 5+/-2 cm from the carina when the head and neck are in neutral position. In 92 of 100 patients studied, the carina overlay T5, T6, or T7 on portable radiographs. Therefore, even when the carina is not visible, it can be assumed that a tube tip positioned at the level of T3 or T4 is safe.

Zamani M et al [26] (2018) found that Ultrasound sensitivity in diagnosis of intubation accuracy was 97.9% (92.94) with 83.3% (5.6%) specificity. The positive and negative predictive values were 98.9% (92.93) and 71.4% (5.7%) respectively. Ultrasound method has high sensitivity and specificity to determine the correct placement of the tracheal tube, and it can be implemented as a reliable method given the acceptable positive and negative predictive values.

We found that in USG, 115(98.3%) doctors had ET tube visualized trachea horizontal view. Association of ET tube visualized trachea horizontal view vs. clinical finding was statistically significant (p <0.0001). ET tube visualized trachea horizontal view Sensitivity was 98.3%, Specificity was 100.0%, Positive Predictive Value was 100.0%, Negative Predictive Value was 66.7 and Accuracy was 98.34%.
It was found that USG, 116(99.1%) doctors had ET tube visualized trachea transverse view. Association of ET tube visualized trachea transverse view vs. clinical finding was statistically significant (p <0.0001). ET tube visualized trachea transverse view Sensitivity was 99.1%, Specificity was 100.0%, Positive Predictive Value was 100.0%, Negative Predictive Value was 80.0and Accuracy was 99.17%.

Thomas VK et al [27] (2017) found that Out of the 100 intubation attempts, five (5%) had esophageal intubations. The sensitivity and specificity of diagnosis using ultrasonography were 97.89% and 100%, respectively. This was statistically comparable with the other two modalities. The time taken to confirm tube placement with ultrasonography was 8.27 ± 1.54 s compared to waveform capnography and clinical methods which were 18.06 ± 2.58 and 20.72 ± 3.21 s, respectively. The time taken by ultrasonography was significantly less. Ultrasonography confirmed tube placement with comparable sensitivity and specificity to quantitative waveform capnography and clinical methods. But then, it yielded results considerably faster than the other two modalities.

We found that in ET tube visualized trachea horizontal view, the mean Years of experience (mean± s.d.) of doctors was 3.9043 ± 1.9375 Year. The difference of mean Years of experience: ET tube visualized trachea horizontal view was statistically significant (p=0.0057).

Our study showed in ET tube visualized trachea transverse view, the mean Years of experience (mean± s.d.) of doctors was 3.8879± 1.9371 Years. The difference of mean Years of experience: ET tube visualized trachea transverse view was statistically significant (p=0.0098).

CONCLUSION

We found that procedure of upper airway ultrasound is valuable in dealing with critically ill patients especially in airway management because of its mobility, non-invasiveness, cost-effectiveness. With the advent of improved standard of care in airway ultrasound assessment and multiple numbers of evidence based studies, we can inculcate using point of care ultrasound in endotracheal confirmation by emergency physicians.

Table: Association between ET tube visualized trachea horizontal view: Clinical Finding and ET tube visualized trachea transverse view: Clinical Finding

Clinical Finding				
		Yes	**No**	**p-value**
ET tube visualized trachea (horizontal view)	**Yes** Row % Col %	115 100.0 98.3	0 0.0 0.0	<0.0001
	No Row % Col %	2 33.3 1.7	4 66.7 100.0	
ET tube visualized trachea (transverse view)	**Yes** Row % Col %	116 100.0 99.1	0 0.0 0.0	<0.0001
	No Row % Col %	1 20.0 0.9	4 80.0 100.0	

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