

Real Time Point of care Ultrasonography *versus* Auscultation for the confirmation of Endotracheal *versus* Bronchial Intubation in Emergency Department

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Abstract: Aims and objectives: To study the accuracy of real time point of care ultrasonography(POCUS) in confirming the endotracheal tube position during emergency intubations. Method: This was a prospective randomized controlled study done in the Department of Emergency Medicine at SS Institute of Medical Sciences and Research Centre (SSIMS&RC), Davangere, Karnataka, India. Three residents(one for endotracheal intubation,one for POCUS, one for auscultation) and a consultant emergency physician trained in POCUS conducted the study to determine the accuracy of POCUS. The residents were blinded to share their findings. Result:1)The study showed that the sensitivity of POCUS is 94.6% and specificity is 86.5% in determining the position of ETT whether it was in trachea or right main bronchus whereas the auscultation showed the sensitivity of 82.7% and specificity of 57.7% for the same. 2)The study showed that the sensitivity of POCUS is 97.6% and specificity is 81% in determining the position of ETT whether it was in trachea or left main bronchus whereas the auscultation showed the sensitivity of 92.4% and specificity of 62%for the same. Conclusion: The present study proved that the Real Time Point of Care Ultrasonography is more accurate than auscultation in determining the position of endotracheal tube during emergency intubations.

Keywords: POCUS, Emergency Intubation

1. Introduction

Airway management has been the first priority in all the patients presenting to the ED(Emergency Department). Establishing a definitive airway, mainly, endotracheal tube(ETT) placement, is an important part of emergency airway management in the ED. ETT insertion is one of the routinely done procedures by the Emergency Physicians (EP). The confirmation of ETT position is crucial as the early detection of oesophageal intubation and detection of ETT malpositioning plays a vital role in prevention of morbidity and mortality. Inadvertent endobronchial intubations are bound to happen during Emergency intubation. Hence identifying the correct location of ETT within the trachea remains challenging.

There are many methods for the confirmation of ETT placement. The gold standard for the confirmation of ETT placement is measurement of End tidal carbon dioxide(ETCO₂) according to American Heart Association guidelines for Cardiopulmonary Resuscitation[1]. But the ETCO₂ monitor will not ideally detect and differentiate between tracheal and endobronchial intubations.

Auscultation has been the standard for determining ETT location and is recommended by institutions such as the American Heart Association,[2] as well as major Anesthesiology and Perioperative Care text books.[3]

However, the use of auscultation to distinguish between tracheal and bronchial intubation has been shown to be unreliable, with a reported sensitivity of only 60 to 65%. [4-6]

Point-of-care ultrasound(POCUS) is defined as ultrasonography brought to the patient and both performed and interpreted "real-time" by the provider.[7] It is quick and inexpensive, and with the recent development of handheld ultrasound device, it is already readily available in the clinical areas where endotracheal intubation occurs. Recent evidence has supported the use of point-of-care ultrasound for the detection of esophageal *versus* tracheal intubations with reported sensitivity/specificity of 100% for adult patients in the operating room[8] and 100%/86%, respectively, in patients undergoing cardiopulmonary resuscitation.[9] In fact, the 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care recommend the use of ultrasound as an adjunct tool to confirm correct tube position when carbon dioxide monitoring is not available.[10]

The present study aims at determining accuracy of real time Point of care tracheal and lung ultrasonography versus auscultation to confirm correct placement of ETT.

2. Materials and Methods

2.1. Study Design

This was a prospective randomized controlled study done in the Department of Emergency Medicine at SS Institute of Medical Sciences and Research Centre (SSIMS&RC), Davangere, Karnataka, India. The institutional ethical committee clearance was taken to conduct the study.

2.2. Selection Criteria

All the patients who underwent endotracheal intubation in the Emergency Room were included in the study. The demographic variables, the various indications for the intubations and the study protocols were documented. The patients who were intubated by the ambulance personnel, intubated and referred from a different hospital, patients who were put on Philadelphia neck collar, patients with suspected chest trauma and the patients who were brought to the ED(Emergency Department) in cardiac arrest were excluded from the study.

2.3. Sample Size And Study Period

Total 374 patients were studied between December 2015 and November 2016.

2.4. Study Protocol

The study was done by the Emergency Medicine residents. There were three residents who were all trained in emergency ultrasonography and the study was done under the supervision of one consultant emergency physician. The consultant emergency physician supervised all the emergency intubations and POCUS and stopped the study on any patient where the untoward complications signalled to compromise the patient's prognosis at any point during the study.

The first resident took the role of emergency intubation procedure. The type of intubation(rapid sequence intubation or delayed sequence intubation), selection of drugs for induction, selection of type and size of ETT was the decision of the first resident under the guidance of the consultant emergency physician, depending on the indications and vital parameters of the patient. All the intubations were done under direct laryngoscopy.

The second resident, who stood on right side of the patient does the POCUS. The portable ultrasound machine from GE healthcare, LOGIQ e, type of machine was used during the study. A linear probe 12L-RS type 5-13 MHz was used

during the study. The second resident, keeps the probe horizontally in lower neck, about 2cm above the suprasternal notch and traces upwards towards the cricothyroid membrane and holds the probe there to observe the endotracheal intubation in real time. The screen of the ultrasonund machine was faced away from all other residents to eliminate the bias. The patients who had oesophageal intubation were immediately informed/signalled by the second resident to the consultant emergency physician and the study was re-done and the data was recorded. Once the second resident confirms himself about the endotracheal position of ETT, he immediately performs the lung ultrasonography. The second resident, places the probe vertically in 2nd and 3rd intercostals space in midclavicular line and checks for the pleural sliding sign using both two dimensional and M-mode ultrasonography. The second resident notes down his findings in a predetermined chart and hands over to the consultant emergency physician.

The third resident, who stands on left side of the patient, does the five point auscultation, notes down his findings in a predetermined chart, and immediately hands over to the consultant emergency physician. The consultant emergency physician takes the final call, to reconfirm and fix the ETT.

2.5 Statistical Analysis

The primary outcome was the ability to detect bronchial *versus* tracheal intubation using the PLUS ultrasound examination compared to auscultation. Currently published detection rates with stethoscope auscultation show a 65% sensitivity.[11]. All proportions were tested using a chi-square test without correction. A value of $P < 0.05$ was considered statistically significant, and all Confidence intervals are presented at the 95% level.

3. Results

374 patients were studied between December 2015 and November 2016. 34 patients were excluded from the study because of the oesophageal intubations and the requirement of the consultant emergency physician to intervene and stop the study only to benefit the patient's outcome.

Demographics

Out of the 340 patients studied, 249 were male and 91 were females. Mean age was 42+/- 15 years. Most common indications for emergency intubations in the ED were severe traumatic brain injury, organophosphorous compound poisoning.

Table 1: Results of Chest Auscultation vs. Point-of-care Ultrasound Lung Examination: ETT positioning-Tracheal vs. Right Main Bronchus

	True Final position		total	Auscultation	True Final position		Total
	Trachea	Right Main Bronchus			Trachea	Right Main Bronchus	
POCUS							
trachea	245	7	252	trachea	206	22	228
Right Main Bronchus	14	45	59	Right Main Bronchus	43	30	73
total	259	52	311	total	249	52	301
Sensitivity=94.6%			Sensitivity=82.7%				
Specificity=86.5%			Specificity=57.7%				

Positive Predictive Value=97.2% Negative predictive value=76.3% P value <0.05	Positive Predictive Value=90.4% Negative predictive value=41.1% P value <0.05
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The study showed that the sensitivity of POCUS is 94.6% and specificity is 86.5% with positive predictive value of 97.1% and negative predictive value of 76.3% in determining the position of ETT whether it was in trachea or

right main bronchus whereas the auscultation showed the sensitivity of 82.7% and specificity of 57.7% with positive predictive value of 82.7% and negative predictive value of 41.1% for the same.(Table 1)

Table 2: Results of Chest Auscultation vs. Point-of-care Ultrasound Lung Examination: ETT positioning-Tracheal vs. Left Main Bronchus

POCUS	True Final position			Auscultation	True Final position			Total
	Trachea	Left Main Bronchus	total		Trachea	Left Main Bronchus	total	
trachea	245	4	249	trachea	206	8	214	
Left Main Bronchus	6	17	23	Left Main Bronchus	17	13	30	
total	251	21	273	total	223	21	244	
Sensitivity=97.6% Specificity=81% Positive Predictive Value=98.4% Negative predictive value=74% P value <0.05				Sensitivity=92.4% Specificity=62% Positive Predictive Value=96.3% Negative predictive value=43.3% P value <0.05				

The study showed that the sensitivity of POCUS is 97.6% and specificity is 81% with positive predictive value of 98.4% and negative predictive value of 74% in determining the position of ETT whether it was in trachea or left main bronchus whereas the auscultation showed the sensitivity of 92.4% and specificity of 62% with positive predictive value of 96.3% and negative predictive value of 43.3% for the same.(Table 2)

4. Discussion

Currently published detection rates with stethoscope auscultation show a 65% sensitivity.[11]. The auscultation cane of clinician dependent and also varies and difficult to make a proper clinical judgement in certain conditions like poor perfusion statuses, shock, respiratory distress syndrome. The trained emergency physician can have an advantage with the availability of POCUS in the ED. POCUS gives better judgement and can be easily performed and usually does not vary among the trained emergency physicians.

The point-of-care ultrasound examination performed in this study (PLUS) can identify appropriate placement of ETT at the midtracheal level. Similarly, capnography can be useful for identifying if the ETT is in the airway or the esophagus, but it cannot reliably detect wherein the airway the tube has been placed.[12] Chest x-rays expose patients to harmful radiation and also require time to capture and develop the image during which a patient could be improperly ventilated. Lastly, arterial blood gasses can detect issues with oxygenation in the blood but cannot specifically identify problems in ETT placement.

The present study proved the better detection rate of bronchial intubation with POCUS when compared to auscultation. The use of tracheal dilation proved to be the most useful to the emergency physician to determine whether or not the tracheal cuff was in the main trachea. Once this was determined, the assessment of pleural sliding aided with suggesting the possible bronchial location. However, this was more challenging for the emergency

physician to interpret. This is likely secondary to the fact that it remains difficult to completely isolate a lung field with a standard single-lumen ETT such that no pressure is delivered and thus prevent pleural sliding. This point emphasizes the importance of looking at both components of the POCUS examination to determine ETT location, as lack of lung sliding may be secondary to other pathology besides bronchial intubation (pneumothorax, mucous plug, pleural fibrosis, etc.), which is a common limitation with auscultation. In spite of all these, POCUS has shown better results compared to auscultation.

5. Conclusion

The present study proved that the Real Time Point of Care Ultrasonography is more accurate than auscultation in determining the position of endotracheal tube during emergency intubations in ED. The present study also showed that Point of Care Ultrasonography is a very valuable tool for the Emergency Physician to determine the position of Endotracheal tube in real time. The emergency physician trained in POCUS will have better success rate of proper positioning of the ETT during emergency intubations.

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