

Diagnostic Accuracy of Tracheal Rapid Ultrasound Exam (TRUE) for Confirming Endotracheal Tube Placement in Emergency Intubation Using X-Ray as Gold Standard

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ABSTRACT

Aim: To determine the diagnostic accuracy of Tracheal Rapid Ultrasound Exam for detection of endotracheal tube placement.

Methods: A total of 230 patients with indications of ETT tube placement of age ranges from 25-65 years of both gender were included. Patients with tracheostomy, severe cervical injury and NG tube placement were excluded. All these patients were first undergone Tracheal Rapid Ultrasound Exam for detection of endotracheal tube placement and then underwent lateral neck X-ray and findings of both were correlated.

Results: Mean age was 44.73±7.39 years. Out of these 230 patients, 147(63.91%) were male and 83 (36.09%) were females with male to female ratio of 1.77:1. The sensitivity, specificity, PPV, NPV and diagnostic accuracy of Tracheal Rapid USG Exam for detection of endotracheal tube placement taking Lateral X-Ray neck as gold standard was 98.80%, 95.24%, 98.21%, 96.77% and 97.83% respectively.

Conclusion: This study concluded that TRUE is a non-invasive imaging modality of choice with a high diagnostic accuracy for detection of endotracheal tube placement.

Keywords: Endotracheal tube placement, imaging modality, non-invasive, sensitivity.

INTRODUCTION

Endotracheal tube (ETT) placement is the primary and definitive way of managing critically ill patients¹. Endotracheal intubation (ETT) is a rapid, safe and non-surgical technique that achieves all the goals of airway management, mainly, maintains airway patency, protects the lungs from aspiration and permits leak free ventilation during mechanical ventilation². According to the Advanced Cardiac Life Support guidelines of 2000, a confirmatory method should be done for proper insertion of the ETT and to exclude esophageal or endobronchial intubation³.

Ultrasound imaging technique has recently emerged as a novel, simple, portable, non-invasive tool helpful for airway assessment and management⁴. There is high morbidity and mortality in critically ill patients if there will be unrecognized esophageal intubation⁵. Lateral X-ray is the gold standard for secondary confirmation of the endotracheal tube placement with sensitivity and specificity of 100%^{6,7}. One of the main limitations of chest x-ray is that it requires time for its results to be interpreted and viewed by the resuscitating team⁸.

Ultrasound of thorax is another way to confirm endotracheal tube placement. This method has advantages that it can be used in pre-hospital settings or during medical transports where auscultation is not possible⁹. The tracheal tube can be directly visualized by sonography for positioning in the trachea¹⁰. Ultrasound has many advantages over other available imaging modalities or endoscopy as it is not expensive, safe and easily and widely available¹¹.

We have conducted this study to determine the diagnostic accuracy of Tracheal Rapid Ultrasound Exam (TRUE) for detection of endotracheal tube placement taking Lateral X-Ray neck as gold standard, so our population could be provided with the non-invasive, real time diagnostic approach that would be non-ionizable, mobile, less position dependant, less time consuming and cost-effective and would have higher diagnostic accuracy than routinely used X-ray, and could be utilized in such critical patients.

MATERIALS AND METHODS

This descriptive, cross sectional study was done on 230 patients with indications of ETT tube placement i.e. cardiac arrest with ongoing chest compression, inability of a conscious patient to adequately ventilate/oxygenate, inability of the patient to protect their airway (coma GCS<9, areflexia, loss of gag reflex) and inability to ventilate the unconscious

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patient with conventional methods, age 25-65 years of both genders were selected for the study. Patients undergoing tracheostomy, severe cervical spine injury and having other tubes like NG tube placed were excluded from the study.

After taking informed consent, ultrasound was performed by the researcher under supervision of her supervisor by using TOSHIBA Nemio USG machine equipped with linear probe of 5 MHz. Grey scale USG of neck with special emphasis on visualization of trachea and ETT tube was performed in all patients by using linear array transducer by placing it over suprasternal notch. All these patients were then underwent lateral neck X-Ray and findings were noted and correlated with ultrasound findings.

Data was analyzed by using SPSS Version 10.0. Mean and standard deviation was calculated for numerical variables. Frequency and percentage was calculated for qualitative variables like. 2x2 contingency table was used to calculate sensitivity, specificity, PPV, NPV and diagnostic accuracy of ultrasound in proper placement of ETT in trachea taking lateral neck X-ray as Gold standard. P ≤ 0.05 will be taken significant.

RESULTS

Age range in this study was from 25-65 years with mean age of 44.73±7.39 years. Majority of the patients 66 (28.69%) were between 36 to 45 years of age. Out of these 230 patients, 147(63.91%) were male and 83 (36.09%) were females with male to female ratio of 1.77:1.

Table: Summary of results.

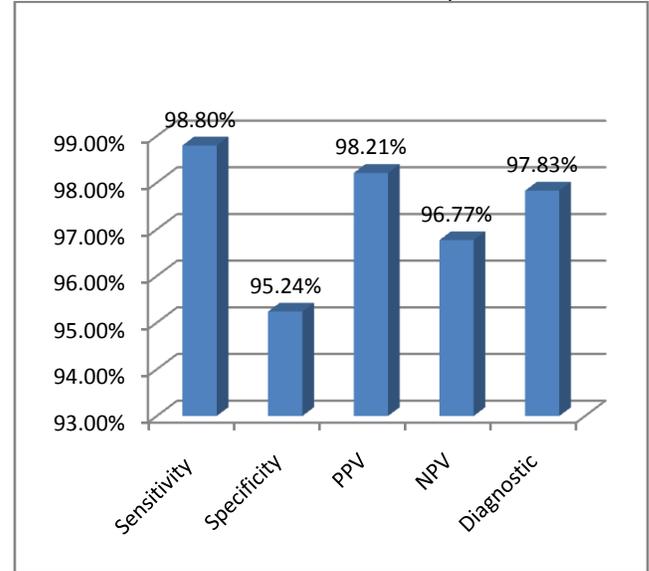
	+ve USG findings	-ve USG findings
Positive X-ray findings	165 (TP)*	02 (FN)***
Negative X-ray findings	03 (FP)**	60 (TN)****

*-TP=True positive **-FP=False positive ***-FN=False negative ****-TN=True negative P value=0.917

All the patients were subjected first to USG of neck with special emphasis on visualization of trachea and ETT tube and then underwent lateral neck X-Ray. Ultrasound supported the correct ETT placement in the trachea in 168 patients. Lateral neck X-Ray confirmed correct ETT placement in the trachea in 167 patients. In USG positive patients, 165 (True Positive) had correct ETT placement in the trachea and 03 (False Positive) had ETT placement in the esophagus on lateral neck X-Ray. Among, 62 USG negative patients, 02 (False Negative) had ETT placement in the trachea on lateral neck X-Ray where as 60 (True Negative) had ETT placement in the esophagus on lateral neck X-Ray as shown in Table I. Overall sensitivity, specificity, PPV, NPV and diagnostic accuracy of Tracheal Rapid USG Exam

(TRUE) for detection of endotracheal tube placement taking lateral X-Ray neck as gold standard was 99%, 95.24%, 98.21%, 96.77% & 97.83% respectively.

Fig. I: Diagnostic accuracy of Tracheal Rapid Ultrasound Exam for detection of endotracheal tube placement.



DISCUSSION

Ultrasonography (US) is a commonly used modality in emergency department. It is relatively safe, inexpensive, portable and easily and widely available modality.¹² Several studies on use of ultrasound in confirming the endotracheal tube placement showed promising results in a cadaver model¹³ or patient in a controlled operating room setting^{14,15}.

In our study, Ultrasound supported the correct ETT placement in the trachea in 168 patients. Lateral neck X-Ray confirmed correct ETT placement in the trachea in 167 patients. In USG positive patients, 165 (True Positive) had correct ETT placement in the trachea and 03 (False Positive) had ETT placement in the esophagus on lateral neck X-Ray. Among, 62 USG negative patients, 02 (False Negative) had ETT placement in the trachea on lateral neck X-Ray where as 60 (True Negative) had ETT placement in the esophagus on lateral neck X-Ray. Overall sensitivity, specificity, PPV, NPV and diagnostic accuracy of Tracheal Rapid Ultrasound Exam (TRUE) for detection of endotracheal tube placement taking Lateral X-Ray neck as gold standard was 98.80%, 95.24%, 98.21%, 96.77% and 97.83% respectively.

In a study done by Chou HC et al¹⁶ the sensitivity, specificity, PPV and NPV of T.R.U.E (Tracheal Rapid Ultrasound Exam) were 98.9%, 94.1%, 98.9% and 94.1% respectively. Marciniak B et al¹⁷ and Werner SL et al¹⁸ in their studies have found the sensitivity and specificity of sonography as 100%

for detecting endotracheal tube placement in trachea. Similarly, Muslu B et al¹⁹ has also shown the sensitivity and specificity of 100%. Adi O et al²⁰ found the sensitivity, specificity, PPV and NPV of bedside upper airway U/S as 98%, 100%, 100% and 75%.

In a prospective clinical trial done by Park SC et al²¹ in South Korea, the sensitivity and specificity of T.R.U.E (Tracheal Rapid Ultrasound Exam) were found to be 100% and 100% respectively. In another study, 127 patients in emergency department were enrolled, out of which 24 (19%) patients have shown the correct ETT placement on chest radiography. Ultrasound and chest radiography agreed on endotracheal tube placement in 106 patients with 74% in trachea (94 tracheal and 12 main stem).⁸ The sensitivity and specificity of ultrasound for tracheal placement was 91% and 50% respectively. Hosseini JS et al²² has also shown the sensitivity and specificity of 92% and 96% respectively. Drescher MJ et al²³ examined the use of sonography to confirm tracheal and esophageal placement using a sagittal view of the trachea in a small number of cadavers and found sensitivity of 100% and specificity of 98% of ultrasound for detection of endotracheal intubation. Sonography is an operator-dependent technique, but it is relatively simple to learn. The use of sonography to confirm tracheal intubation is attractive for several reasons. It is a useful, quick, repeatable, noninvasive, pain-free, portable, and direct anatomic method for assessment of the tracheal tube position¹⁰.

CONCLUSION

Tracheal Rapid Ultrasound Exam (TRUE) is a non-invasive imaging modality of choice with a high diagnostic accuracy for detection of endotracheal tube placement than routinely used X-ray. So, we recommend that TRUE should be used as a primary imaging modality for detection of endotracheal tube placement as it is non-invasive, non-ionizable, mobile, less position dependant, less time consuming and cost-effective imaging modality for our general population.

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