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Successful endotracheal intubation guided by tracheal ultrasonography in a critical patient with a difficult airway

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Abstract:

In critical care, effective airway management, especially during cardiopulmonary resuscitation (CPR), is vital. Endotracheal intubation, although common, poses challenges in patients with difficult airways. Traditional methods for confirming tube placement, particularly during CPR, can be unreliable. Tracheal ultrasonography is emerging as a valuable tool for guiding intubation and confirming tube placement in real time. A case of a 72-year-old with respiratory distress, chronic obstructive pulmonary disease, and heart failure is described. Despite initial treatment, emergency intubation was necessary, but the initial attempt failed due to a difficult airway. Tracheal ultrasonography guided the intubation process and confirmed tube placement in real time, leading to successful intubation and improved outcomes. This technique shows promise in optimizing airway management during CPR, offering real-time visualization, and minimizing complications. This case underscores the potential of ultrasound-guided techniques in emergency airway management. Further research is needed to fully understand their benefits and limitations in such settings.

Keywords:

Difficult airway, endotracheal intubation, real-time ultrasound guidance, tracheal ultrasonography

Introduction

The provision of airway patency safety and effective respiration during critical patient care and cardiopulmonary resuscitation (CPR) is an essential component of advanced life support.[1] Endotracheal intubation, a routine procedure in emergency medicine, is crucial for maintaining airway patency. However, inadvertent esophageal intubation carries significant risks, including mortality and morbidity. Studies report incidence rates of improper tube placement during cardiac arrest ranging from 2.9% to 16.7%, highlighting the importance of accurate placement.[2,3] In addition to traditional methods such as direct visualization of the vocal cords, observation of chest expansion, listening to lung sounds, and vaporization of the inner wall of the tracheal tube, the use of quantitative waveform capnography and ultrasonographic assessment (including tracheal ultrasonography, detecting sliding of the pleura, or diaphragm movement) have become increasingly common recently.[1,4-9]

In cases with clear vocal cord visibility during intubation, tube placement confirmation is routine. However, visibility challenges arise in patients with difficult airways. Ensuring accurate tube placement is not always feasible, with limitations in observing chest expansion and lung sounds. Relying on these methods during CPR can disrupt compressions, compromising CPR quality.[4,5] Therefore, correct endotracheal intubation and confirming tube placement

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are crucial in critically ill patients and during cardiac arrest. The present study describes a case of a critically ill patient with a difficult airway undergoing tracheal ultrasonography-guided intubation, which also confirmed tube placement accuracy.

Case Report

A 72-year-old patient with chronic obstructive pulmonary disease and heart failure presented to the emergency department (ED) with respiratory distress. The patient exhibited tachypnea (24–28 breaths per minute) and was using auxiliary respiratory muscles. Mild cyanosis was noted in the fingertips. Vital signs revealed a temperature of 37.2°C, heart rate of 112 beats per minute regular, arterial blood pressure of 110/60 mmHg, and pulse oximetry reading of 87%. Pretibial edema was observed as ++. Lung auscultation revealed weak or absent breath sounds in the bilateral lower zones, especially on the right side, with rales in the middle zones. The patient received 100% oxygen support through a face mask and was administered selective beta-2 adrenergic receptor agonist (Ventolin) 2.5 mL nebulization. Intravenous access was established, and routine blood tests were ordered. Bedside ultrasonography revealed bilateral pleural effusion, though more noticeable on the right hemithorax, and bilateral widespread B-Lines on thoracic ultrasonography, leading to the initiation of diuretics for suspected pulmonary edema. Despite interventions, saturation improvement could not be achieved, and the pulse oximeter dropped to 75%–80%. Due to decreased consciousness and increased respiratory effort, the decision was made to conduct rapid sequence intubation. The patient was planned to be administered 1.5 mg/kg of ketamine for induction, but cardiac arrest occurred before the administration, and chest compressions were initiated and performed continuously by the emergency nurse. One mg adrenaline was administered intravenously to the patient in asystole. Intubation was initiated by the emergency physician during CPR, but the first attempt was unsuccessful due to difficulty visualizing the vocal cords caused by the patient's short neck and large tongue.

The second intubation attempt was performed with trans-tracheal ultrasound guidance. A paramedic, trained in "Prehospital Ultrasonography," used a linear probe to visualize the trachea transversely under the cricoid cartilage just above the suprasternal notch. Real-time guidance from the ultrasonography screen facilitated the tracking of the tracheal tube. During this procedure, a trained paramedic was involved in monitoring the ultrasonography screen and conveyed the images on the ultrasonography screen to the emergency physician. To avoid compromising the quality of CPR, chest compressions were performed continuously by the emergency nurse, whereas the paramedic and the emergency physician worked together to complete the intubation, with the paramedic monitoring the ultrasonography and guiding the tube placement. The endotracheal tube (ETT) was initially observed on the ultrasonography screen to be directed toward the esophagus at the beginning of the second attempt [Figure 1], prompting the paramedic to guide the practicing physician in slightly withdrawing and redirecting the tube back toward the trachea with ultrasonography assistance. Confirmation of tube placement by the paramedic was achieved when the tube passed through the trachea, as indicated by the simultaneous appearance of a shadow artifact and the absence of the second tract of the esophagus in the image (double tract sign) [Figure 2]. After confirmation, the tube was advanced slightly further, and the procedure was successfully completed [Figure 3]. After the return of spontaneous circulation, an X-ray was performed to confirm the correct placement of the ETT, which corroborated the ultrasonographic findings. The patient was then connected to a mechanical ventilator, and a chest tube was placed on the right hemithorax before admission to the intensive care unit.

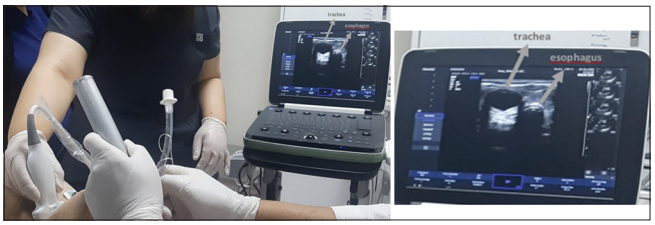

Figure 1: Intubation under transtracheal ultrasonography guidance. Trachea on the left, esophagus with the endotracheal tube on the right, double tract sign

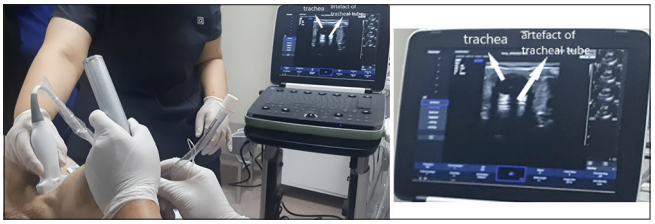

Figure 2: Simultaneous appearance of a shadow artifact and the absence of a double track sign

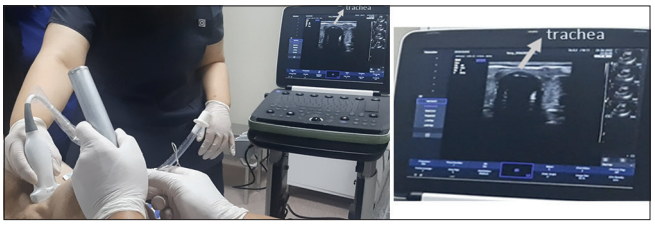

Figure 3: Absence of esophagus image on the screen, only tracheal image is visible, no double tract sign

Discussion

Ultrasonography, a dynamic and operator-dependent technique, is widely used as a repeatable, noninvasive, and real-time diagnostic tool in various EDs and critical care settings. Tracheal ultrasonography, when performed by trained individuals, can be a valuable adjunct in resuscitation management. However, there are limited data available regarding the use of ultrasonography in airway management during CPR.

Ultrasonography's popularity in airway management is increasing due to the relatively superficial position of the laryngopharynx in the anatomy.[10] There is a growing trend in using ultrasound to locate the ETT following intubation attempts, especially in patients experiencing cardiac arrest. The use of ultrasound to assess ETT placement postintubation has been the subject of increasing research.

The present study shared a successful endotracheal intubation procedure performed under ultrasonography guidance in a critical patient with a difficult airway in the emergency resuscitation room. In our setting, the use of alternative methods such as bronchoscopy, video laryngoscopes, or esophageal detector devices was unavailable. Therefore, ultrasonography was employed as the primary method to guide and confirm tube placement during CPR. Using tracheal ultrasonography during the procedure not only guided the process but also simultaneously confirmed the placement of the tube. In the images of the procedure, the ETT is seen initially misplaced in the esophagus, prompting its retraction and redirection toward the trachea under the guidance of simultaneous ultrasonography imaging. The second attempt was successful, and the passage of the ETT into the trachea was observed simultaneously on the tracheal ultrasonography screen.

Ultrasonography is currently being used to confirm the placement of the ETT during resuscitative procedures. Previous researchers have employed various techniques for sonographically assessing the position of the ETT, such as direct tracheal ultrasonography, as well as detecting pleural sliding or diaphragm movement.[7-9,11,12]

The 2010 American Heart Association Guidelines for CPR and Emergency Cardiovascular Care recommend quantitative waveform capnography as the preferred method to confirm the correct placement of the ETT. However, it is important to note that waveform capnography relies on adequate ventilation and effective pulmonary blood flow. Quantitative waveform capnography may yield incorrect positive results (for instance, in patients who have not fasted and exhibit gastric CO_2 production)[12] and incorrect negative results (such as in cases of airway obstruction, reduced pulmonary flow, administration of epinephrine, or technical errors) during CPR.[4,6] In individuals with compromised circulatory perfusion, especially those experiencing cardiac arrest, the accuracy of waveform capnography diminishes. In such cases, there may be inadequate delivery of carbon dioxide to the lungs, resulting in an unreliable confirmation of proper tracheal intubation.[13,14] Previous research has shown that auscultation missed identifying esophageal placement in 0.4%–15% of cases.[5] Chest auscultation and observing chest wall expansion are frequently used techniques to verify tracheal intubation. Nonetheless, employing these methods interrupts chest compressions and prolongs the duration without blood flow during CPR. Using ultrasonography guidance for endotracheal intubation allows for earlier confirmation of tube placement and earlier detection of improper displacement compared to traditional methods (observation of chest expansion, listening to lung sounds, vaporization of the inner wall of the tracheal tube, and quantitative waveform capnography.[15-18]

Conclusion

The present study described the successful endotracheal intubation procedure guided by tracheal ultrasonography, where the movement of the tube was tracked on the ultrasonography screen. Initially, it advanced erroneously into the esophagus, but upon slight retraction and subsequent advancement, it correctly entered the trachea, indicating a successful intubation. Thus, the ultrasonography image served as both guidance during the procedure and simultaneously confirmed the tube's placement. During intubation, real-time tracheal ultrasonography was conducted using a linear transducer positioned transversely just above the suprasternal notch to evaluate ETT placement and rule out esophageal intubation. Real-time tracheal ultrasonography serves as a precise tool for guiding endotracheal intubation and confirming tube placement during CPR, all without interrupting chest compressions.

Author's contribution

BG conceived and designed the study, analyzed and curated data, wrote the preliminary draft, and took responsibility for data integrity and accuracy. BG also collected, edited, and reviewed the final manuscript and approved it for submission.

Conflicts of interest

None Declared.

Declaration of patient consent

The author certifies obtaining appropriate patient consent forms. Consent was obtained from the patient's daughter, as the patient had passed away in the intensive care unit. The daughter consented to report her father's images and clinical information in the journal, with the assurance of anonymity measures.

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