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The evaluation of efficacy of three different ultrasonography methods for verification of gastric tube placement in intensive care unit patients

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Abstract

Gastric tube (GT) placement is a routine procedure in critically ill patients. Improper placement of GT could lead to severe complications. Radiography remains as the gold standard test to confirm tube position. The study aim is to estimate diagnostic accuracy of three different ultrasonography (USG) methods to verify GT placement in intensive care units (ICU). Twenty-five mechanically ventilated patients were included in this prospective and observational study. All real time US examinations were performed by an intensivist in three steps: sonography of neck for visualizing esophagus and upper abdominal quadrant for visualizing stomach, and visualization of dynamic fogging during water and air insufflations in gastric area. Finally, gastric placement of GT was confirmed with abdominal radiography. USG visualized GT in esophagus in 24 (96 %) patients. GT was directly visualized in stomach in 16 (64%) patients and dynamic fogging occurred in 20 (80 %) in the first attempt and in 23 (92 %) patients after tube removal. Because gastric tube was not seen in stomach in nine cases, dynamic fogging allowed to confirm intragastric position in seven cases. In two cases, no dynamic fogging was observed, and radiography confirmed tube malposition in esophagus. Entire sonographic procedure took 7.24±2.58 minutes. Visualization of the esophagus and dynamic fogging improves the diagnostic accuracy of USG in verifying GT position. Confirming correct GT placement by USG has the potential to reduce X-ray usage and save time. However, X-ray remains the gold standard in cases in which USG cannot verify placement of the GT.

Keywords: Esophagus, gastric tube placement, intensive care unit, ultrasonography

Introduction

Gastric tube (GT) placement is a routine procedure in critically ill patients for various purposes, including enteral nutrition and medicine administration. The improper placement of GT is a rarely seen entity (0.5-11%) and could lead to severe complications [1,2]. Tracheobronchial misplacement can also lead to aspiration pneumonia, asphyxia or even deaths [3-5].

Radiography remains the gold standard test to confirm tube position. The aim of this observational study is to estimate the diagnostic accuracy of three different ultrasonography (USG) methods to verify GT placement in intensive care units (ICU). Therefore, physicians should control the best appropriate position of GT. A number of bedside methods, such as auscultation ("whoosh test"), gastric aspirate pH or appearance and capnography, are used to confirm the location of GT [6-8]. The sensitivity and specificity of all these techniques are lower than direct radiography, still remaining as the gold standard to confirm the location of GT. However, radiography is associated with undesirable factors, such as exposure to ionizing radiation, cost and time-consuming [9,10]. In recent years, increasing number of studies have examined the efficacy of USG as an

alternative to radiography for confirming the position of GT [11-17]. However, there are controversial and conflicting results on diagnostic accuracy, and there is no consensus on the role of USG in routine clinical practice. In addition, direct visualization of stomach as a definitive verification method can be difficult due to interposition, gastric content and patients' characteristics (obese or excessively mobile) [11-14]. Therefore, additional methods, such as combining different scanning points and visualization of dynamic fogging or Doppler signal due to air insufflation can be used to improve the accuracy of diagnosis [15-18]. In our previous study, we revealed that passing of GT through the esophagus could be visualized at a higher rate in real time with USG [19].

The aim of this study is to evaluate the three different methods performed by USG in confirming the position of GT in critically ill ICU patients.

Material and Methods

After obtaining approval from the local ethics committee, this prospective, single-centered and observational study was performed in 25 mechanically ventilated patients in an

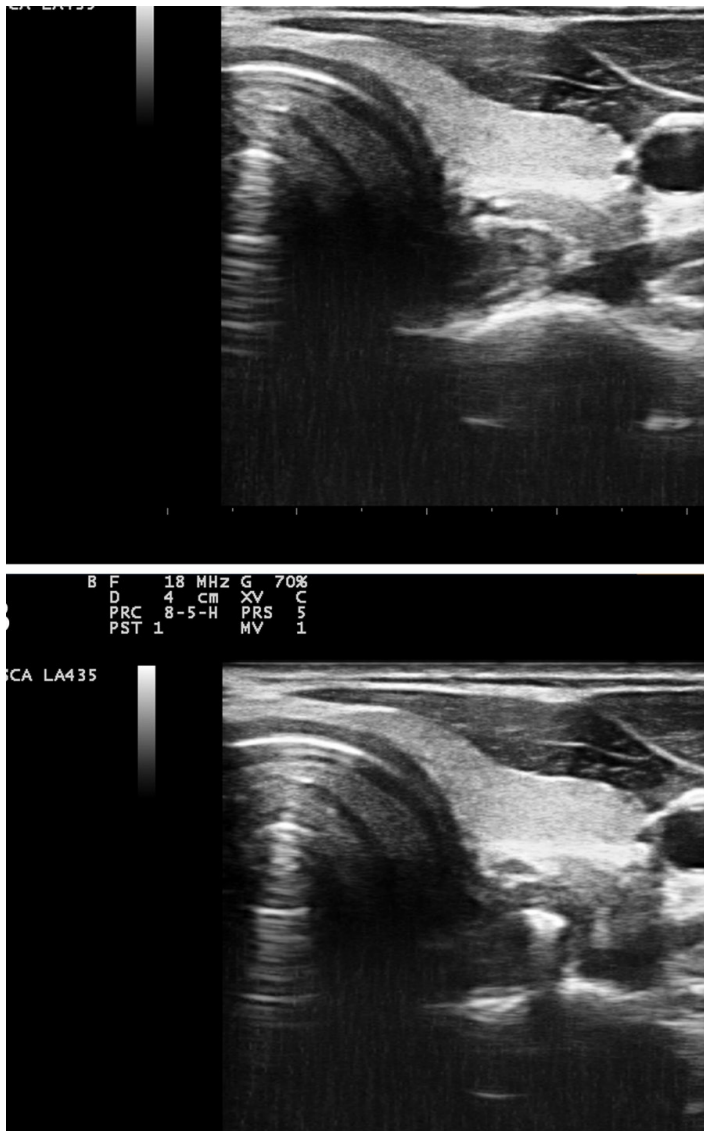
ICU between November 2016 and March 2017 in accordance with the ethical standards of the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Esophageal and gastric USGs were performed before, during and after the placement of GT to confirm the location of GT. Exclusion criteria

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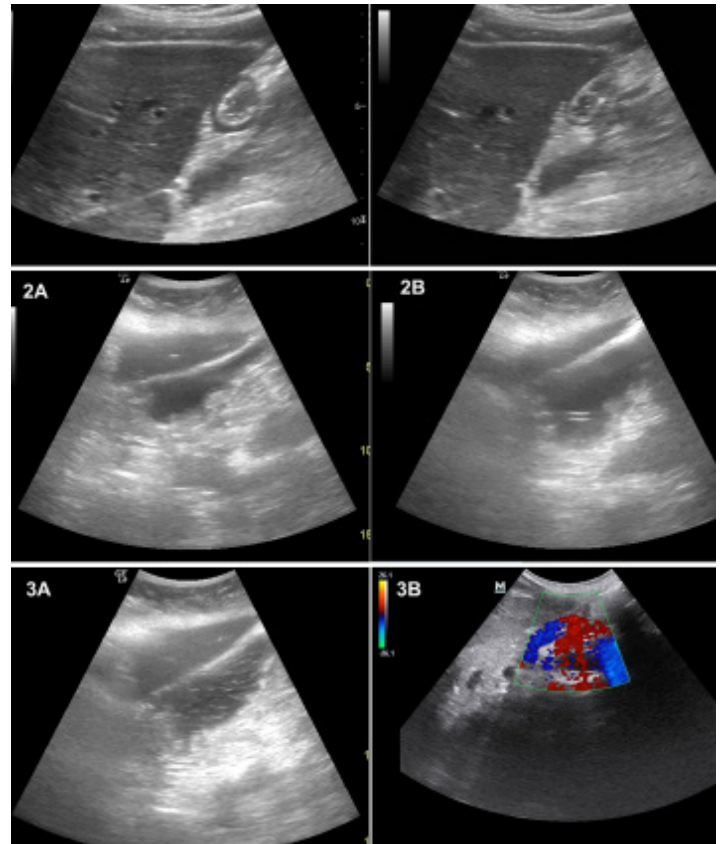
consisted of such features as pregnancy, age <18 years, anatomic deformity and contraindication in GT placement (caustic substance ingestion, nasal fracture, coagulation disorder and neck surgery). The polyvinylchloride GT with a caliber of 10 or 14 French (Bexen, Enteral Feeding Tube, Spain) was used in the study. The size of GT was selected according to the diameter of the nostril of the patient, and the tip of GT was lubricated with a gel before the placement. Sonographic examinations were performed by the same intensivist experienced on airway USG and attending a training course on gastric USG.

All real-time USG examinations were performed in three steps as esophageal USG, gastric USG and the detection of dynamic fogging or color Doppler signal (i.e. dynamic gastric USG).

1. Esophageal USG: The procedure was performed with the method defined in the study by Gok et al. [19]. In performing the procedure, a high-frequency linear USG transducer (4-10 MHz, GE Logiq-e, Mississauga, ON, Canada) was transversely placed over the suprasternal notch. The concentric layers of the esophagus were attempted to be viewed on the posterolateral side of the trachea (generally left) by shifting the probe. If the esophagus could be seen, an attempt was made to insert GT under real-time USG. The visualization of a hyperechoic circle was defined as a positive result when GT was gently advanced (Figure 1).



2. Gastric USG: Initially, the subxiphoid and left upper abdominal regions were scanned transversely and longitudinally to obtain the image of the antrum and gastric bodies using a convex transducer (3.5-5 MHz). The antrum was imaged as an ovoid structure (bull's-eye pattern) located posterior to the left hepatic lobe. The antrum was easier to visualize the antrum with sonography when the gastric volume decreases due to the increasing in wall thickness. Secondly, the transducer was angled lightly towards to the subcostal region, and the gastric body was imaged. At this time, by the visualizing the hyperechoic line parallel to each other, GT was detected (Figure 2) [18].



3. Dynamic Gastric USG: If esophageal GT transfusion was seen, we looked for USG scanning through the fogging or color Doppler flow detection at the same time of 40 ml sterile fluid and air mixture injection. If nogastric placement of GT could be confirmed by these three methods, the assessment of aspirate content as the traditional method and the verification with abdominal radiography were performed. The time between nasal entry of the tip of the tube and the verification of gastric tube placement by USG was recorded.

Results

This study was carried out in 25 patients followed-up in ICU under mechanical ventilation. The clinical and demographic characteristics of the patients are described in Table 1.

Screening with USG before the procedure detected GT in esophagus in 96% (n = 24) of all cases. When was advanced through the esophagus, it was displayed in real time in all of these patients. Despite scanning both left and right sides in one patient, the esophagus could not be visualized and was thought to be located posteriorly of the trachea. In such patients, GT was directly visualized with gastric USG. Gastric screening was performed

before the procedure did not display the antrum in 6 patients.

Four of these patients were on total parenteral nutrition, and GT was administered for any reason. GT was directly visualized in the stomach in 16 (64%) patients. In nine cases, no gastric tube was seen in stomach, and then the dynamic fogging allowed to confirm intragastric position in seven cases. In other two cases, no dynamic fogging was observed, and radiography confirmed malposition of the tube in the esophagus. Dynamic fogging occurred in 20 (80

%) patients in first attempt, and the confirmation was made by radiography in five cases. GT was detected in lower esophagus in two cases and in abdomen in three cases. GT was considered to be in a more advanced position, after the tube was withdrawn, dynamic fogging occurred in these three patients (Fig 2). The average time spent for the confirmation of gastric tube position by USG was 7.24 ± 2.58 minutes. The verification by radiography was 58.32 ± 15.19 minutes. There was no tracheobronchial placement, and no serious complications were observed during the study.

Table 1 . Demographic and clinical characteristics of patients (n=25)

Mean age \pm SD/range (year)	37.04 \pm 18.03 (18-77)
Sex (male/female)	17/8 (68%,32%)
BMI (kg/m ²)	28.4
APACHE II	12.8
Diagnostic criteria	
• Trauma	12
• Postoperative respiratory failure	5
• Intoxication	4
• Cardiac arrest	4
Number of patients in whom GT was monitorized sonographically in esophagus	24 (96%)
Number of patients in whom antrum was monitorized	19 (76%)
Number of patients in whom GT was monitorized sonographically in gastric area	16 (64%)
Number of patients monitorized through fogging or Doppler signal	
First attempt	20 (80%)
Second attempt	23 (92%)
Time of procedure \pm SD/range (minute)	
USG	7.24 \pm 2.58 (3-14)
Abdominal radyography	58.32 \pm 15.19(15-88)
Tracheal placement of GT	None
Other complications	None

BMI: Body mass index, GT: Nasogastric feeding tube, USG: Ultrasonography, SD: Standard deviation

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Discussion

The incidence and distribution of dermatological diseases In order to determine the localization of GT, the effectiveness of different

methods performed with USG was evaluated in the present study. First, the tube was shown to advance in the digestive system instead of respiratory system to monitor GT in cervical esophagus. Then, the certain location was defined with the direct monitoring of GT in the stomach. Finally, with the dynamic fogging due to air insufflation, the determination of the localization was supported when non-monitoring of the tube in the stomach was prevented due to any reason.

In addition, the color changes of gastric juices due to the turbulences occurring after aspiration and insufflation, and Doppler signals were monitored. USG investigations were performed by an ICU specialist in an easy and rapid manner.

Within all patients, GT was directly monitored in esophagus and stomach in 96% and 64%, respectively. Dynamic fogging was detected in 80% of all patients at the first attempt, while being detected in 92% at the second.

Although the placement of GT is a simple and widespread procedure used routinely in patients in ICUs, faulty placement of GT may lead to life-threatening complications in such patients. Faulty handling procedures of GT may lead to thoracic and non-thoracic complications. Among some of the tracheobronchopleural complications caused by faulty procedures are pneumonia, bronchial perforation, atelectasis, penetration of pleural cavity and pulmonary hemorrhages. However, widespread non-thoracic complications are intravascular penetration, mediastinitis, posterior nasopharynx, esophageal and duodenal perforation, and intracranial localization. Therefore, the position of GT should certainly be controlled; however, no standard method healthcare providers have built a consensus on so far has been present for the accurate position of GT [1-4].

The gastric-content aspiration is another method used frequently to confirm the position of GT. However, the reliability of this method is lower if the tube is soft or the stomach is empty [6,7].

The gastric auscultation or “whoosh test” performed when the air is simultaneously blown through the tube is the most widespread and simplest controlling method. Nevertheless, auscultation is not specific enough because sounds within the esophagus can mistakenly be perceived. Higher failure rate of auscultation method has been documented in previous studies [7].

Other rare methods, such as the pH test performed via the aspiration of GT and the colorimetric capnography, have also been used to confirm the placement of gastric tube [19]. The pH test is not indicated in patients treated with some drugs such as H2 blockers and fail to distinguish between intestinal and tracheal replacements of GT [20].

In the confirmation of the tube position, the radiography still remains as the gold standard method. The short comings accompanying with the radiography are exposure to ionizing radiation, unwanted conditions arising while changing the patient’s position such as catheters, drains and dislocation of tracheal tubes accidentally, need for a radiology technician during the procedure and cost-effectiveness [20, 21].

The sonography is another technique used increasingly by ICU

specialists in many different procedures. For the first time, the sonography was used by Hernandez-Socorro et al. (2013) to confirm the accurate position of a naso-enteric feeding tube during the passage of pylorus [22]. In studies performed in later period, the success rates related to the monitoring of tubes via gastric USG are controversial [15,17].

Lock et al. (2003) confirmed the placement of GT with the insufflation of 50 mL air in 55 patients hospitalized in ICU. In the study, the accurate placement was confirmed with USG in 43 (72%) of 60 feeding tubes [12]. In another study, Vigneau et al. (2005) reported that USG had quicker results in 35 hospitalized patients in ICU, compared to radiography, and the placement of GT was confirmed in 97% of all cases with higher sensitivity [13]. On the other hand, in a study performed by Kim et al. (2012) the effectiveness of sonographic methods was compared, and that the success rates of sonographic methods were found to be lower, compared to the findings of other studies [17]. The success of gastric USG depends on different factors, such as gastric content, gas intervention and experience of provider.

Cheinata et al. confirmed the position of GT in gastric region at the rate of 89% (n=130) through the direct monitoring [14]. In a study performed in 132 patients by Brun et al. (2014), the position of GT was confirmed in esophagus in 100% of all patients and in stomach in 62.5% through USG. Mean confirmation time of GT position was 18 seconds [15]. In our study, we also found similar results those found in the study by Brun et al (2014). In our study, gastric USG failed to confirm the accurate position of GT in seven patients due to full stomach and gas intervention. In seven patients, the position of GT was monitored with dynamic fogging.

However clearly our findings revealed the success of USG, our study is limited because it is a single-centered study and was performed only in ICU patients.

In our study, USG revealed that GT was in digestive system instead of respiratory system at the rate of 96% and the certain localization at the rate of 80%, and so the requirement for radiography can be reduced by USG.

The sonography is still used as the gold standard method in conditions where USG images cannot be obtained. USG can easily and rapidly confirm the placement of GT in critical patients and also be performed by all medical and nursing staff. However, sonographic examination is difficult in some cases due to patients’ characteristics and conditions in practice. Therefore, scanning of different points together with USG, and concomitant use of USG with other methods, such as dynamic fogging, color flow detection and Doppler, can increase the success rate.

In conclusion, the visualization of the esophagus and dynamic fogging improves the diagnostic accuracy of USG in confirming GT position. The confirmation of accurate GT placement by USG has a potential to decrease the use of X-ray and to save time. However, X-ray remains as the gold standard technique in cases where USG cannot verify placement of the GT. We consider that further studies with different patient populations are needed to support the findings and to standardize the procedure.

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