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Ultrasound to confirm gastric tube placement in prehospital management☆

Hichem Chenaitia[a,*], Pierre-Marie Brun[b], Emgan Querellou[b], Jérome Leyral[c], Jacques Bessereau[d], Christine Aimé[e], Renaud Bouaziz[e], Arnaud Georges[f], Fabrice Louis[f], WINFOCUS (World Interactive Network Focused On Critical Ultrasound) Group France

[a] Department of Emergency Medicine and Radiology, Clavary General Hospital, Grasse, France
[b] Prehospital Emergency Medical Service, BMP (Bataillon des Marins Pompiers), Marseille, France
[c] Department of Emergency Medicine, Laveran Military Hospital, Marseille, France
[d] Emergency Medicine Service, Timone University Hospital, Marseille, France
[e] Department of Radiology, Clavary General Hospital, Grasse, France
[f] Department of Prehospital and Emergency Medicine, Clavary General Hospital, Grasse, France

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ABSTRACT

Background: In emergency medicine, the gastric tube (GT) has many purposes, however in prehospital settings, the only indication is gastric decompression. To date, there is lack of recommendation on the diagnostic methods to verify correct GT placement in prehospital. The aim of this study is to estimate diagnostic accuracy of ultrasound in confirming gastric tubes placement in a prehospital setting.
Method: This was a prospective multicentre study conducted in two French towns (Marseille and Grasse) over a one-year period from May 2010 to May 2011.
Results: One hundred and thirty patients were included in the study with an M/F sex ratio of 77/53 and a mean age of 55.7 ± 19.8 years. The GT position was confirmed by ultrasound, with direct visualization in the gastric area in 116 of the 130 patients. In 14 cases, the ultrasound failed to visualize the tip of the GT; these results were due in 2 cases to gas interposition and in 12 cases the GT was shown by final X-ray to be located in the end of the oesophagus. Direct visualization by ultrasound thus has a sensitivity of 98.3% [94–99.5] and a specificity of 100% [75.7–100], a positive predictive value of 100% and a negative predictive value of 85.7%, Youden's index of 0.98. GT size affects ultrasound visualization; the larger the GT, the easier it is to see.
Conclusion: Bedside ultrasound thus appears to constitute an effective and reliable diagnostic procedure for confirming correct gastric tube placement in prehospital settings.

1. Introduction

In emergency medicine, the gastric tube (GT) has many purposes such as evaluation and treatment of gastrointestinal haemorrhage or after toxic ingestion, and gastric decompression in cases of bowel obstruction or in cases of distension due to assisted ventilation. However, in prehospital settings, the only indication for GT insertion is gastric decompression, especially after gastric distension secondary to bag-valve-mask ventilation or assisted ventilation.

Whilst the misplacement rate appears low (between 0.5 and 1.5%), the exact frequency is difficult to determine.[1] The complications are exceptional may be very serious, such as perforation or misplacement in the tracheobronchial tree, possibly with pneumothorax, pneumomediastinum, subcutaneous emphysema, pneumonia, pulmonary haemorrhage, empyema, haemothorax, bronchopleural fistula, mediastinitis, and perforation of the oesophagus, and even in rare cases, intravascular or intracranial misplacement.[1–8] Moreover, for critically ill patients managed by an emergency physician in a prehospital setting, there are several major underlying factors favouring tube misplacement, including impaired gag reflex, recent endotracheal intubation, decreased laryngeal sensitivity and neuromuscular blocking drugs.[1–4]

Our current protocol in prehospital settings to verify correct GT placement is the auscultation method or "whoosh test" (instillation of air in the tube with sounds heard simultaneously through a stethoscope placed over the stomach region) combined with the aspirate method (visual inspection of aspirate contents). However, in recent years, many publications and guidelines have recommended that these methods should not be used to verify appropriate GT placement in the stomach.[9] Instillation of air in

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* Corresponding author at: Service de Médecine d'Urgence et de Radiologie, Centre Hospitalier General de Clavary, Grasse, France. Tel.: +33 4 91499191; fax: +33 4 91386943.
E-mail address: chenaitiahichem@gmail.com (H. Chenaitia).

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Fig. 1. The two ultrasound machines used in the study: (a) Titan, Sonosite, portable ultrasound with a convex probe (5–2 MHz). (b) V-Scan, General Electric Healthcare, ultraportable ultrasound with a phased array probe (1.7–3.8 MHz).

small-bore tubes does not always allow sufficient passage of air and peristalsis may be mistaken for insufflated air; air bubbling in the pleura, lung or oesophagus may be transmitted below the diaphragm, and an inexperienced operator may misinterpret what is heard; moreover, in prehospital settings the environment is often noisy. Aspiration of fluid may result from the pleural space, from bronchial secretions or even from the brain.[1–4] However, to date, no other recommendations or alternative methods have been proposed for prehospital settings.Prehospital use of bedside ultrasound has become widespread over the last decade. Our Mobile Intensive Care Units (MICUs) are now equipped with hand-held ultrasound devices to perform ultrasonographic examinations in prehospital settings: Extended Focused Assessment Ultrasound in Trauma (EFAST), Rapid Ultrasound for Shock and Hypotension (RUSH) exams and the Bedside Lung Ultrasound in Emergency (BLUE) protocol. The literature shows that ultrasound has already been used for GT and feeding tube verification, but its use in a prehospital setting has not been evaluated.[10–12]

The aim of this study is to estimate diagnostic accuracy of ultrasound in confirming gastric tubes placement in a prehospital setting.

2. Methods

2.1. Study design

This was a prospective multicentre study in patients undergoing GT insertion in a prehospital setting conducted in two French towns (Marseille and Grasse) over a one-year period from May 2010 to May 2011.

2.2. Study setting

To evaluate the efficacy of ultrasound in confirming accurate GT placement in prehospital settings, two emergency physicians performed an ultrasound exam after GT insertion, and after verification by the auscultation and aspiration methods; the sole aim of this examination was to determine whether or not the GT could be viewed in the stomach. It was stipulated that ultrasound results must not affect patient management or cause any delay in treatment or in transport, and the physician had to follow the usual procedures.

2.3. Population

Inclusion criteria: patients aged 18 years or older in prehospital settings and requiring GT insertion.

Exclusion criteria: patients aged under 18 years, pregnant women, inter-hospital transfers, and absence of X-ray control.

2.4. Protocol

The local ethics committees approved the protocol. The GT was inserted by the nursing team with the physician verifying correct placement. A GT could be inserted into stomach though the nose (NasoGastric Tube [NGT]) or the mouth (OroGastric Tube [OGT]). The only indication for inserting a GT in prehospital settings was gastric decompression. The contraindications were caustic ingestion, and severe head injury or mild facial injury. The Nose–Ear-Xiphoid (NEX) method was used to calculate tube insertion distance. The gastric tube size was twice the width Endo-Tracheal Tube (ETT) size or equal to the diameter of the patient's nostril. The end of GT was lubricated before insertion in all cases. For non-trauma patients, the patient's neck was flexed and the nurse passed the GT gently through the nostril. If the tube did not pass easily, the opposite nostril could be tried, or a smaller tube. The tube was not forced under any circumstances. If NG passage was unsuccessful the OG approach was used. If the tube emerged from the mouth or the patient coughed, the procedure was temporarily stopped before further attempts at insertion. For trauma patients: where possible, insertion of a GT was to be avoided or else OG insertion was preferred, maintaining in-line stabilization of the cervical spine (neutral position). Our protocol in prehospital settings to verify correct GT placement involved the auscultation method or "whoosh test" (instillation of air in the tube with sounds heard simultaneously through a stethoscope placed over the stomach region) combined with the aspirate method (visual inspection of aspirate contents). The tube was secured to the bridge of the nose and to the cheek using adhesive tape. Our protocol also required final confirmation of GT placement by radiography on arrival at hospital, the X-ray is the test method reference standard to confirm correct GT placement.

After insertion and securing of the GT, the emergency physician verified the correct placement of GT by ultrasound. The emergency physicians who performed this ultrasound exam are experienced and certified in emergency ultrasound, a training during one day has been dedicated to study the specificities of this type ultrasound exams. Two ultrasound machines were used; in Marseille, a portable ultrasound system (Titan, Sonosite) with a convex probe (5–2 MHz), and in Grasse, an ultraportable ultrasound system (V-Scan, General Electric Healthcare) with a phased array probe (1.7–3.8 MHz) (Fig. 1). The technique was standardized; the probe was placed in the subxiphoid area then oriented towards the left

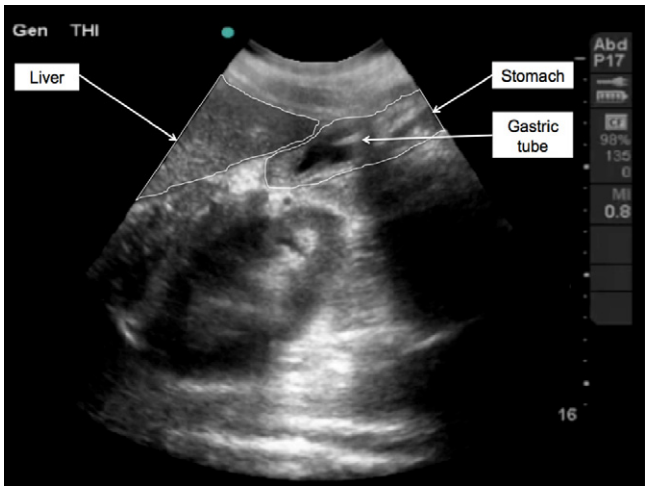

Fig. 2. Gastric tube visualization by a portable ultrasound device (Titan, Sonosite) with a convex probe (5–2 MHz). The tip appears as a hyperechogenic line in the stomach.

upper abdominal quadrant to visualize the stomach, with transverse viewing, the antrum was imaged in a transversal plane in the epigastric area using the left lobe of the liver as internal landmark, the gastric body was imaged by angling the transducer towards the left subcostal area. The ultrasound exam is considered as positive when the GT tip is view in its length, it appearing as a hyperechogenic line in the stomach (Figs. 2 and 3). The examination time was limited to 1 min to avoid any delays. A video was recoded showing the GT tip; two radiologists review each video to confirm the results.

2.5. Data collection

The emergency physicians completed the study forms immediately after the procedure. The study form included patient age and sex, clinical status, GT size, time of ultrasound exam, whether or not the GT was visualized in gastric area by ultrasound, and GT position by radiography.

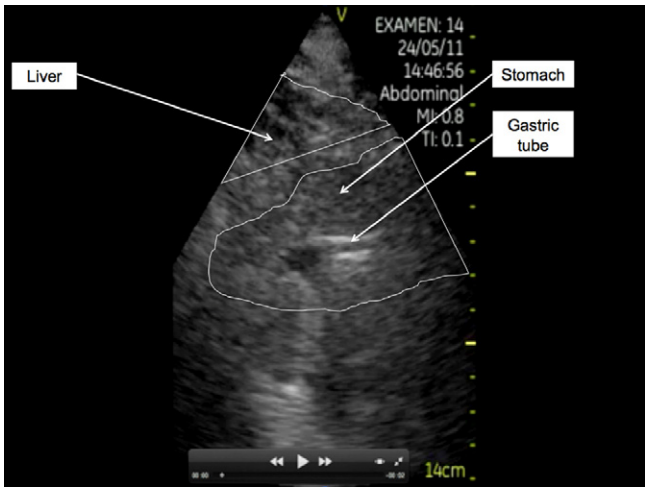

Fig. 3. Gastric tube visualization by an ultraportable ultrasound device (V-Scan, General Electric Healthcare) with a phased array probe (1.7–3.8 MHz). The tip appears as a hyperechogenic line in the stomach.

2.6. Statistical analysis

Data were collected by two emergency physicians and entered in a database. All statistical analyses were performed using statistical software. All continuous variables are expressed as means with standard deviations, and a Student's *t*-test was performed. All categorical variables are expressed as numbers with percentages, and a Chi^2 test or Fisher's exact test were performed. A value of $p < 0.05$ was considered statistically significant for all tests.

3. Results

One hundred and thirty patients were included in the study with an M/F sex ratio of 77/53 and a mean age of 55.7 ± 19.8 years. 96 patients were included in Marseille and 34 in Grasse; the epidemiological characteristics (sex and age) of the 2 groups were not statistically different. All patients were intubated and mechanically ventilated in a prehospital setting. All GTs were verified using our prehospital protocol (auscultation and aspirate methods) and considered as being in the stomach. The GT position was confirmed by ultrasound, with direct visualization in the gastric area in 116 of the 130 patients. In 14 cases, the ultrasound failed to visualize the tip of the GT; these results were due in 2 cases to gas interposition and in 12 cases the GT was shown by final X-ray to be located in the end of the oesophagus (Fig. 4).

GT position was confirmed by radiography throughout, with no cases of serious complications; the GT was in the oesophagus in 9% of cases but it was not positioned in the respiratory tract in any of the patients.

Direct visualization by ultrasound thus has a sensitivity of 98.3% [94–99.5] and a specificity of 100% [75.7–100], a positive predictive value of 100% and a negative predictive value of 85.7%, Youden's index of 0.98 (Table 1).

Seven 18-Fr GTs were inserted and all were visible, ninety-four 16-Fr GTs were inserted and 98% were visible, and 29 14-Fr GTs were inserted and 81% were visible. GT size affects ultrasound visualization ($p = 0.002$); the larger the GT, the easier it is to see.

4. Discussion

The findings confirm the high sensitivity and specificity of ultrasound in confirming accurate GT placement in adult patients, even when performed by emergency physician and in a prehospital setting.

In prehospital settings, ultrasound has already been used to check the bilateral sliding lung to confirm endotracheal tube placement and to rule out selective intubation since it is more reliable than clinical examination.[13] This application of ultrasound already forms part of our daily practice. Our study confirms the possible extension of ultrasound examination to confirmation of GT placement in prehospital settings. Ultrasound may also be used to ensure correct GT repositioning after accidental displacement during prehospital transportation.

When a foreign object such as a GT is inserted into the body, it can cause injury at various points from the site of entry to the site of distal placement. The literature on prehospital emergency medicine provides no information about GT misplacement or associated complications. Although the complication rate with GT insertion is low (between 0.5 and 11%), it is not negligible.[14] During this study, no serious complications were seen, but the population was relatively small. The findings show that the NEX method seems inaccurate in determining the length of GT to be inserted, thus demonstrating an underlying need for a new method to calculate the required length, or for performance of ultrasound examination

Table 1
Diagnostic accuracy of ultrasound in confirming gastric tubes placement in a prehospital setting.

Ultrasound exam's results	Reference test: X-ray		
	Gastric tube correct placement	Gastric tube misplaced	
Positive test	116 (a)	0 (b)	Positive predictive value [a/(a + b)] 100%
Negative test	2 (c)	12 (d)	Negative predictive value [d/(c + d)] 85.7%
	Sensibility [a/(a + c)] 98.3%	Specificity [d/(b + d)] 100%	

concurrently with GT insertion to provide real-time confirmation of correct GT length and accurate placement.

The positive predictive value of 100% rules out the need for radiography once correct GT placement has been confirmed by ultrasound. In addition, ultrasound is faster than conventional radiography, it reduces radiation exposure of patients and staff, and it requires no patient manipulation and no transport. This point-of-care ultrasound exam can be also of interest for unfasted individuals

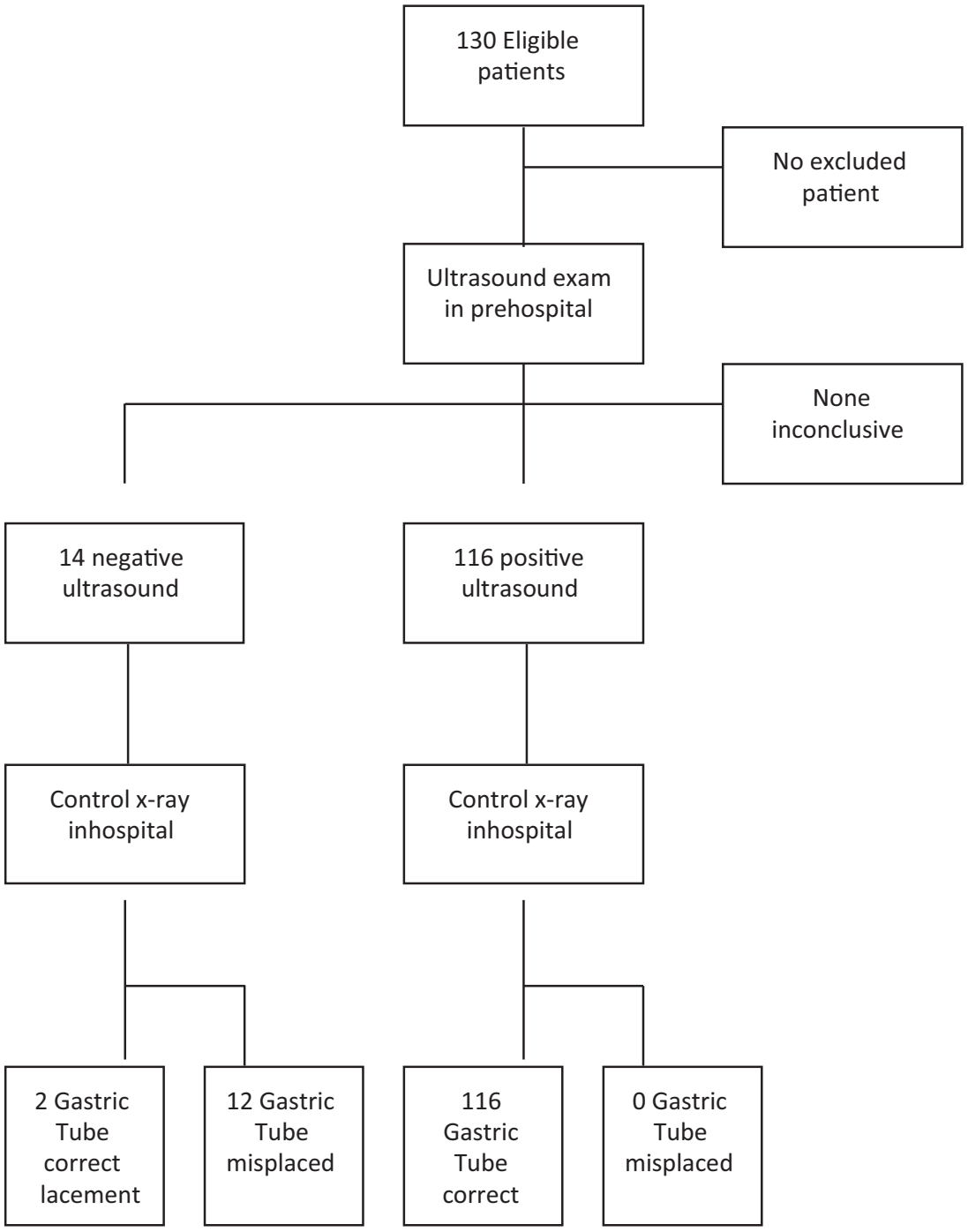

Fig. 4. Flow diagram for diagnostic accuracy of ultrasound in confirming gastric tubes placement.

in acute care settings within hospitals, where the use of point-of-care ultrasound is common.

Our findings show that larger GTs are more readily visible. Although it seems obvious, the smaller the GT, the more difficult it is to see.

The only failures in our series were due to gas interposition, which remains a major limitation of ultrasound. Radiography may be reserved for ultrasound failure due to gas interposition, since obtaining a radiograph in the emergency department or intensive care unit can be time-consuming, in addition to which it exposes patients to radiation.

However, further studies are needed to confirm these results and to determine the best method for such point-of-care ultrasound examination, the training needed to perform this ultrasound exam, the best approach to view the gastric region, the best probe.

4.1. Limitations

The principal bias of this study is that appropriate blinding techniques could not been adopted to decrease bias, because this technique is new, without previous data on the feasibility or the reliability; and thus the emergency physician had to follow the usual procedures.

Another bias is that almost all patients studied in prehospital settings had "unfasted" with sonographically detectable gastric content, thus facilitating GT visualization.

Another limitation was that the investigators have very extensive experience in ultrasound. It is uncertain whether a novice or intermediary performer could identify the tip of the GT so easily and rapidly, especially in a context of extreme stress common in prehospital settings. We ignore the training needed to be able to carry out this type of ultrasound examination.

The time assigned to GT visualization was deliberately restricted to avoid any treatment delay, but the examination may be performed during transportation with the vehicle in motion, and in this case the sensitivity of direct visualization by ultrasound may be better.

5. Conclusion

In summary, in prehospital setting, point-of-care ultrasound is a simple, reliable and sensitive method to confirm correct positioning of a gastric tube in the upper gastroduodenal tract. Radiography could be reserved for ultrasound failure due to gas interposition. However, further studies are needed to confirm these results and to determine the best method for such point-of-care ultrasound examination.

Conflict of interest statement

None to declare.

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