

# Comparision of ultrasonography with direct radiography and aspiration for the confirmation of nasogastric tube placement among intubated patients in the emergency servise: A prospective, single-blind, cross-sectional study

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## Abstract

**Aim:** The position of the nasogastric tube should be confirmed after its initial insertion and prior to repeated use. The present study makes a prospective comparison of the efficacy of ultrasonography, aspiration and direct radiography in confirming nasogastric tube placement among intubated patients.

**Materials and Methods:** This prospective, single-blind and cross-sectional study included 45 (16 female and 29 male) patients over the age of 18 who were intubated and had a nasogastric tube inserted at the Emergency Service between 01.03.2017 and 30.08.2017. For the confirmation of NGT placement, both gastric aspiration and gastric auscultation were performed by the primary physician who initially inserted the NGT. The abdominal USG was performed by an emergency physician who had performed the procedure 20 times previously.

**Results:** The ultrasound had a sensitivity of 92%, a specificity of 100%, a positive predictive value of 100% and a negative predictive value of 50%. The direct radiography had a sensitivity of 57%, a specificity of 100%, a positive predictive value of 100% and a negative predictive value of 14%. The aspiration method, in turn, had a sensitivity of 78.57%, a specificity of 66.67%, a positive predictive value of 97.06% and a negative predictive value of 18.18% as a means of NGT placement confirmation.

**Conclusion:** Bedside ultrasonography is more effective than the aspiration method and direct radiography for the placement confirmation of NGT inserted into intubated patients in the emergency service.

**Keywords:** Aspiration method; direct radiography; emergency service; intubated patients; Nasogastric tube; ultrasound

## INTRODUCTION

Nasogastric tubes are used for the sampling of gastric contents, gastric detoxification, enteral nutrition, drug administration and gastric decompression in intensive care clinics and in the emergency room. A nasogastric tube is the means of providing enteral nutrition and oral drug administration to intubated patients (1). Failure to detect the misplacement of a nasogastric tube early may lead to serious complications, such as aspiration pneumonia, pulmonary laceration, pneumothorax and pneumocephalus due to intracranial placement (2). In order to avoid such complications, the position of the nasogastric tube should be confirmed after its initial insertion and prior to repeated use. The methods most commonly used to confirm NGT placement are gastric

auscultation, aspiration of gastric contents, pH testing of aspirates, bedside abdominal ultrasound and direct radiography (direct chest and abdominal radiography) (3,4). The present study reports on a prospective comparison of the efficacy of ultrasonography and direct radiography in confirming the nasogastric tube placement among intubated patients.

## MATERIALS and METHODS

The study included 45 (16 female; 29 male) patients over the age of 18 who were intubated and who had a nasogastric tube inserted in the emergency service of the İzmir Bozyaka Training and Research Hospital between 01.03.2017 and 30.08.2017. Excluded from the study were patients, who were contraindicated for nasogastric tube insertion (severe facial trauma, recent nasal surgery,

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coagulation abnormalities, esophageal strictures or a history of alkaline substance use, history of gastric bypass surgery, recent band ligation of esophageal varices), who were under the age of 18 and who were pregnant. Of the total, 22 patients who were intubated and who had an NGT inserted who underwent a USG died before radiography could be carried out; 18 patients could not undergo direct radiography before referral; and one (1) patient was taken for an emergency operation, and so 41 patients were excluded from the study, even though they had undergone USG.

The full name, gender, diagnosis and admission date of the study patients were recorded. After the primary physician inserted the nasogastric tube into the study patients and confirmed the placement through gastric auscultation and the aspiration of gastric contents, the results were recorded on the data form and the tube was stabilized.

A bedside USG was then performed by an emergency physician with 3 years of experience in USG, but with no knowledge of the presence of the NGT in the stomach, who had successfully performed that USG procedure on at least 20 patients prior to our study, and the result was recorded. The procedure was done by doctors with ultrasound certification.

For the USG procedure, first the entry to the stomach was identified at the border of the liver by scanning from the subxiphoid region to the left upper quadrant using a convex abdominal probe, and the tube was considered to be positioned within the stomach upon the visualization of the hyperechogenicity of the nasogastric tube in this position. In cases when the NGT itself could not be visualized, 30 cc of air was injected into the NGT and the gastric placement of the NGT was confirmed upon the visualization of the hyperechoic image of the exiting air on USG. If the image was negative at the first injection of air, then the abdominal probe was relocated toward the distal stomach in the left upper quadrant, and 30 cc of air was injected one more time in an attempt to visualize the exiting air on USG. If the result was negative in all three attempts, the NGT was not considered to be positioned within the stomach, and the result was recorded as such.

Afterwards, a bedside direct radiography was performed on the patients and interpreted by a different emergency physician with 20 years of experience in emergency medicine who was blind to the results of the other 3 methods. For the interpretation of the direct radiographs, the tube was considered to be positioned within the stomach when the following four conditions were met: the tube had a straight course along the thoracic midline to a point below the diaphragm; the tube did not follow the bronchial course; the tube was not along the thoracic course; and the tip of the tube was below the diaphragm. The tube was considered to be not positioned within the stomach if the radiographs did not meet these four criteria all at once. After the four confirmation procedures of our study were conducted, the primary physician decided whether the NGT was in place based on the results. 50 cc

of air was injected into the NGT and the gastric placement of the NGT was confirmed upon rested with a stethoscope. For the comparison of the collected data, the auscultation method, matching exactly the decision of the primary physician, was taken as the standard reference for the other methods, and the statistical analyses were made accordingly.

The demographic characteristics and the confirmation method results (auscultation, aspiration, USG, direct radiography) of the patients were recorded on the log sheet, and the prospectively collected data was analyzed statistically at the end of the study. For this analysis, the auscultation method performed by the primary physician was taken as the "standard reference", and it was ascertained whether the results of the other three methods differed significantly from this method.

The inserted NGTs were Levin-type tubes with a distal opening and four lateral holes, made from silicone. Either a green (14 Fr), orange (16 Fr) or red (18 Fr) tube was inserted into the study patients. Prior to the insertion, a water-based lubricant gel was applied to the tubes and the tube was secured with a plaster.

The bedside ultrasound used in the study was an Esaote "My Lab 30 Gold" ultrasound machine with three probes for cardiac, abdominal and superficial imaging. For the present study, a convex abdominal probe was selected. The machine permits the video recording of USG images, along with patient details and date information, and the USG images were recorded and stored in this manner.

### Statistical Analysis

Statistical Method: The study data was entered into the database created in the MedCalc 12 program, which was used also for the statistical analyses. Categorical variables were expressed as frequency or percentage, while continuous variables were presented as mean, standard deviation, median, minimum and maximum values. Variations between two dependent groups of categorical variables were compared using McNemar's Test, crosstabs were created for diagnostic test methods, and Sensitivity, Specificity, Positive Predictive Value and Negative Predictive Values were calculated. For the statistical comparison tests, the level of type 1 error was set to  $\alpha$ : 0.05 and tested as two-sided. The between-group difference was considered to be statistically significant if the "p" value was below 0.05.

## RESULTS

The average age of the 45 study patients was 74 years, in a range of 20–94. The standard deviation of the age was 18.7. The study sample of 45 patients comprised 16 (35.6%) females and 29 (64.4%) males. The reason for intubation in the emergency service was type 1 respiratory failure in 25 (55.6%), type 2 respiratory failure in 5 (11.1%), respiratory arrest in 3 (6.7%) and cardiopulmonary arrest in 12 (26.7%) patients.

According to the results of the auscultation method performed and recorded by the primary physician inserting

the NGT into the patients, the air was auscultated in the left upper quadrant in 42 (93.3%) of the 45 patients, while the auscultation was negative over the stomach in three (6.7%) patients. After the initial findings were recorded and the placement confirmation was made by the other confirmation procedures, i.e. aspiration, ultrasonography and direct radiography, three NGTs were observed to be out of place and to be twisted in the esophagus, which were then pulled back and reinserted by the primary physician.

The USG, used instead of direct radiography, of the intubated patients followed a protocol developed by the authors based on a previous research. First, the NGT was visualized within the stomach. Due to the limited echogenicity of the Levin tube used and its limited visualization on USG, we used exiting air as an additional procedure.

The aspiration method through a tapered injector from the tip of the inserted NGT resulted in the aspiration of gastric contents in 34 (75.6%) patients, while no material was aspirated in 11 (24.4%) patients. The bedside ultrasound method resulted in the detection of NGT within the stomach in 39 (86.7%) patients (the exiting air was visualized in 38 patients, while the nasogastric tube itself was visualized in one patient), while the nasogastric tube or exiting air could not be visualized on USG in 6 (13.3%) patients. The direct radiographs acquired by a bedside portable X-ray machine showed the tube within the stomach in 24 (53.3%) patients, while the tube could not be visualized within the stomach in 21 (46.7%) patients (Table 1).

Method	n (%)
<b>Auscultation</b>	
Auscultation Positive	42 (93.3%)
Auscultation Negative	3 (6.7%)
<b>Aspiration</b>	
Aspiration Positive	34 (75.6%)
Aspiration Negative	11 (24.4%)
<b>Ultrasound</b>	
Ultrasound Positive	39 (86.7%)
Ultrasound Negative	6 (13.3%)
<b>Direct Radiography</b>	
Direct Radiography Positive	24 (53.3%)
Direct Radiography Negative	21 (46.7%)
<b>Total</b>	<b>45 (100%)</b>

The ultrasound was positive for 39 of the 42 NGTs placed in the stomach. The number of positive ultrasound results was 0 for the NGTs not placed in the stomach. The ultrasound was negative for six NGTs, although the number of NGTs not placed in the stomach was three. Of the three patients with a false USG negative, one was found to have

the nasogastric tube placed directly in the entrance to the stomach, and therefore no image could be acquired by USG; another had abdominal gas and distention, and so the desired image could not be obtained by USG; and the third patient was considered negative since no USG image could be obtained, even though the nasogastric tube was placed within the stomach. A comparison was made of the results of the bedside ultrasound and the result of the auscultation method (as the standard reference) using McNemar's Test, in which no statistically significant difference was noted between the two methods (Table 2).

**Table 2. Comparison of Ultrasound, Aspiration and Direct Radiography With Standard Reference Method (McNemar's Test)**

	Auscultation			McNemar's Test
	Positive	Negative	Total	
<b>Ultrasound</b>	Positive	39	0	39
	Negative	3	3	6
	Total	42	3	45
<b>Aspiration</b>	Positive	33	1	34
	Negative	9	2	11
	Total	42	3	45
<b>Direct Radiography</b>	Positive	24	0	24
	Negative	18	3	21
	Total	42	3	45

Aspiration was positive for 33 of the 42 NGTs placed in the stomach, and aspiration was negative for 11 NGTs, although the number of NGTs not placed in the stomach was three. Furthermore, aspiration was positive for one NGT that was not placed in the stomach. A later examination of the data found the false positivity to be caused by the gastric content aspiration from the esophageal NGT, and therefore the result was considered positive. In the comparison of the results of aspiration method and the result of auscultation method (as the standard reference) using McNemar's Test, a statistically significant difference was noted between the two methods (Table 2).

The direct radiography was positive for 24 of the 42 NGTs placed in the stomach, and negative for 21 NGTs, although the number of NGTs not placed in the stomach was three. The number of positive direct radiographs was 0 for the NGTs that were not placed in the stomach. In the comparison of the results of the direct radiography method with those of the auscultation method (as the standard reference) using McNemar's Test, a statistically significant difference between the two methods was identified (Table 2).

The statistical analysis of the data revealed that ultrasound had a sensitivity of 92%, a specificity of 100%, a positive predictive value of 100% and a negative predictive value of 50% as a method for NGT placement confirmation. The aspiration method, in turn, had a sensitivity of 78.57%, a specificity of 66.67%, a positive predictive value of 97.06%

and a negative predictive value of 18.18% as a method for NGT placement confirmation. Direct radiography, in turn, had a sensitivity of 57.14%, a specificity of 100%, and a positive predictive value of 100% and a negative predictive value of 14.29% as a method for NGT placement confirmation (Table 3).

**Table 3. Comparing Ultrasound, Aspiration and Direct Radiography with Standard Reference**

	Ultrasound	Aspiration	Direct Radiography
Sensitivity(%)	92.86%	78.57%	57.14%
Specificity(%)	100%	66.67%	100%
Positive Predictive Value(%)	100%	97.06%	100%
Negative Predictive Value(%)	50%	18.18%	14.29%

The Kappa value of the three study methods, calculated from a comparison with the auscultation method, as the standard reference, was 0.634 for ultrasound, 0.202 for aspiration and 0.151 for direct radiography. Since the ultrasound value was closest to 1 among these values, it can be said that statistically, the results of the ultrasound method are closest to the standard reference (Table 4).

**Table 4. Kappa Values of Tests by Standard Reference**

Kappa Values of The Tests	
Ultrasound	0.634
Aspiration	0.202
Direct radiography	0.151

## DISCUSSION

Our study identified bedside abdominal USG as the most effective method for the confirmation of nasogastric tube (NGT) placement for intubated patients among three methods. The sensitivity was 92.8% and specificity was 100% for ultrasound; 57.1% and 100%, respectively for direct radiography; and 78.57 and 66.67%, respectively for the aspiration method.

NGT placement confirmation is a procedure that should be performed with quick and reliable methods (5). Unidentified misplacements have been reported to result in serious complications that may be life threatening, such as pulmonary laceration, pneumothorax, aspiration pneumonia and intracranial placement (6-10). The intubated patient population is a patient group requiring frequent bedside examinations that are associated with difficulties in positioning and limitations in performing tests (11).

The gastric auscultation and gastric content aspiration methods are commonly used in intubated patients, although these approaches remain insufficient for certain patients, leading to a need for further confirmation by direct radiography, which is a well-established approach with a long history.

Tsujimoto et al. suggest that the sensitivity and specificity of X-ray imaging can both increase to 100% if properly interpreted, although this has not been achieved in any study to date (12). Bourgult et al. reviewed NGT malpositioning cases from 1988–2000, and reported a malpositioning rate of 3%. The said study indicated, based on the references reviewed, that there was an “expert opinion” suggesting direct radiography as a means of minimizing malpositioning in patients when the classic methods cannot provide a definite result (13).

The study by Metheny et al. reviewed the guidelines from 2015–2018, and found X-ray to be the optimum approach to the differentiating between a gastric and pulmonary positioning of a gastric tube (14). Our study, in turn, found the sensitivity and specificity of direct radiography to be 57.1% and 100%, respectively. We believe that in our study, the low sensitivity of the direct radiography approach was a result of the use of a portable device, the difficulty in properly positioning intubated patients, the limited exposure of the portable device, the difficulty of esophageal NGT visualization due to the intubation tube and the low radiopacity of Levin tubes.

The aspiration method can be used to check if the NGT is in place. After the insertion of the NGT, aspiration is performed from the external tip of the tube, and any fluid or solid content observed indicates positivity (15). One limitation of this test relates to the possibility of a false negative result due to the lack of content aspiration when the NGT is resting on the gastric wall or when the stomach is empty or when the small tube collapses with the injector (3). The method has a limited use alone, and therefore, generally a pH testing of the aspirated material is performed, with the sensitivity and specificity increasing up to 68% and 79%, respectively, when the pH is <5.5 (16). The present study found the aspiration method to have a sensitivity of 78.57% and a specificity of 66.67%.

Several ultrasonography procedures have been studied for the confirmation of NGT placement. There have been studies demonstrating the live passing of the NGT at the esophageal or gastric level (4,17), while others document radiopacity at the gastric level after NGT insertion (4). In other study, additionally air was ejected externally after the NGT placement, with the expelled air identifiable at the gastric level (18).

In other studies, air and normal saline were shaken in an injector and passed through the nasogastric tube, and the fogging sign at the time of injection was visualized on USG at the gastric level (18). Such studies involve two USG techniques, with one visualizing the esophagus at the tracheal level from the lateral neck using a superficial probe, and the other visualizing the entry to the stomach and further at the border of the liver by advancing from the subxiphoid region toward the left with an abdominal probe (19-22).

Chenaitia et al. carried out a prehospital study in two cities involving 130 patients. Prior to presenting at the hospital,



the patients were fitted with a gastric tube (through the nasal or oral route) by a nurse for gastric decompression, auscultation and aspiration methods were followed by tube stabilization and confirmation with USG. For the confirmation, an abdominal probe was used to visualize the hyperechogenicity of the NGT within the stomach, and sensitivity and specificity were reported to be 98.3% and 100%, respectively (17). The said study differs from the present study as the NGT insertions were made only for gastric decompression, the patients were not classified as conscious or unconscious, the USG method used and the use of direct radiography as the standard reference.

Nedel et al. conducted a single-center, intensive care study involving 41 patients. Feeding tubes were inserted into intubated patients via a radiopaque wire, and placement confirmation was made by visualizing the echogenicity of the wire inside the feeding tube using an abdominal probe. The calculated sensitivity and specificity of the approach were reported to be 97% and 100%, respectively (23). The said study differs from the present study in its insertion of the feeding tube insertion using a wire, being more hyperechogenic than a Levin tube.

## CONCLUSION

In conclusion, bedside ultrasonography is more effective than both the aspiration method and direct radiography as an approach to the confirmation of NGT placement in intubated patients in the emergency service.

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