Imaging Features of Tube Misplacement in All Ages

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Ariel Lewis: Primary author. Performed literature review, wrote and edited manuscript, and submitted manuscript to journal
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Mark Guelfguat: Primary investigator. Primary editor and case provider for manuscript.

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ABSTRACT

Although feeding tube misplacement is rare, its sequelae can be life threatening with significant morbidity and mortality. Increase in cases of gross feeding tube misplacement at our hospital in patients of all ages prompted investigation of misplacement rates and identification of risk factors. Literature review of enteric tube misplacement incidence and complications was performed. This exhibit illustrates the imaging spectrum of tube misplacement and complications both in the gastrointestinal tract and the tracheo-pulmonary tree. Common mimickers of tube misplacement are shown and differentiated. Risk factors for tube misplacement and how to prevent them are discussed at the end of this article.

CASE REPORT

BACKGROUND

The growing nationwide radiologist shortage in the setting of surging imaging utilization has led to increased workload for radiologists both during the day shift and on call [1]. Studies have shown that increased volume can lead to more mistakes [2]. It is therefore imperative that radiologists can quickly and easily identify, often subtle, tube misplacements as they are associated with increased morbidity and mortality.

INTRODUCTION

Small bore enteral tubes are generally indicated for short term use as there are risks in keeping enteric tubes in for a long time. Studies have shown that misplacement of an enteric tube in the airway occurs 2% of the time when performed blindly [3]. Neurological impairment is strongly associated with enteric tube misplacement. Determining proper placement is of the utmost importance, as delay in diagnosis can lead to increased risk of morbidity and mortality. Chest radiography is the current gold standard to confirm tube placement [3]. Other newer, but less ideal, ways to confirm enteric tube placement include pH, capnography, and electromagnetic tracings. Use of clinical signs and auscultation is not accurate in determining correct enteric tube placement. While chest radiography is the gold standard it is not always easily interpreted. On chest radiographs the findings of tube misplacement can be subtle and hence misinterpreted [3]. Enteric tube misplacement within the alimentary tract occurs on a spectrum ranging from proximal to distal malpositions as shown in (Figure 1). Enteric tube misplacement within the respiratory tract also can occur in a spectrum as shown in (Figure 2).

Alimentary Tract Misplacement

Esophageal Misplacement

Esophageal misplacement (Figure 3) is a relatively common malposition. One study of 340 patients documented that esophageal misplacement occurs 2.4% of the time [4]. This occurs more commonly in children with one pediatric study estimating this to occur 18% of the time [5]. Occasionally, an enteric tube enters the stomach but then loops around and returns to the esophagus. Recognizing esophageal placement of the enteric tube is important, as esophageal placement can lead to aspiration [4].

Pharyngeal Misplacement

Rarely, the enteric tube can either loop around in the esophagus and enter the pharynx or loop around in the stomach and enter the pharynx (Figure 4). The literature shows that this phenomenon occurs in approximately 0.3% of all adult cases [4].

Intracranial Misplacement

Intracranial enteric tube insertion causes symptoms corresponding to the area injured by the tube. The literature reports a mortality rate of more than 60% in these patients. Skull surgery or skull trauma, especially a basilar fracture, increases the risk of this malposition [6]. Intracranial misplacement of the enteric tube can also occur following malpositioning in the nasopharynx (Figure 5).

Gastric Perforation

Gastric perforation (Figure 6) occurs more commonly in children than in adults. According to a literature review published in 2021, there have only been 10 documented cases of gastric perforation in adults [7]. In children, risk factors for gastric perforation include low birth weight and prematurity. In adults this complication has been associated with abnormal gastric mucosa including gastritis, gastric cancer, and gastric ulcers. The mechanism behind this complication is poorly understood but is thought to involve pressure ulceration from a rigid enteric tube. Treatment is generally surgical with operative repair and endoscopic clipping being the most common.

Gastrocutaneous Fistula

Gastrocutaneous fistula formation typically occurs in patients with a history of prior gastrostomy tube placement. Following removal of a gastrostomy tube the fistula usually closes within 24 hours. For this reason, it is recommended to wait twenty-four hours between gastrostomy tube removal and enteric tube placement. Rarely, the gastrocutaneous fistula can last longer, in which case the percutaneous endoscopic gastrostomy (PEG) tube (Figure 7) or enteric tube (Figure 8) can be misplaced through the fistula [8]. This can look normal on radiography requiring cross-sectional imaging in cases of strong suspicion.

Bronchopulmonary Misplacement

Laryngotracheal Misplacement

There is a spectrum of imaging features regarding bronchopulmonary misplacement (Figure 2). Depending on how far the enteric tube is placed will determine the sequelae for these misplaced enteric tubes. Laryngotracheal misplacement is a very rare complication, estimated to occur in 0.3% of the population due to coiling of the tube [4] (Figure 9).

Pulmonary Parenchyma/ Pleural Space Misplacement

Pulmonary parenchyma (Figure 10) and pleural space (Figure 11) enteric tube misplacements are rare progressions of mainstem bronchus misplacement occurring in 0.9% and 0.5% of cases respectively [9]. While it can be hard to differentiate the pleural space from the bronchus on radiography, an enteric tube in the pleural space will tend to be more lateral than a tube in the bronchus. Consequences of these misplacements include pneumothorax, hydrothorax, empyema, and possibly even acute myocardial infarction [10].

Penetrated Diaphragm/Retroperitoneal Misplacement

Catheter injury to the diaphragm is extremely rare and has received minimal attention in radiology literature [11]. We describe a case at our institution in which a 72-year-old had a fluoroscopically proven retroperitoneal enteric tube misplacement secondary to a diaphragmatic perforation (Figure 12).

Mimics

When evaluating enteric tube misplacements it is always important to keep common mimickers in mind. For example, an enteric tube in a hiatal hernia (Figure 13) can look to be in the left lower lobe bronchus. Other common mimickers include sutures (Figures 14) and anatomic variations (Figure 15). Knowledge of normal chest and abdominal anatomy is important to be able to differentiate mimics from real tube misplacements. In some cases, cross-sectional imaging is required.

DISCUSSION

Etiology & demographics

Despite a push to increase awareness of tube misplacements, they are relatively common, with two large studies of patients with enteric tubes finding that approximately 2% are misplaced [12].

Clinical & imaging findings

Despite its limitations, chest radiography remains the best imaging modality to evaluate enteric tube placement [12]. Other methods, including auscultation, have been shown to have a high false positive rate. New research on point-of-care ultrasound for enteric tube confirmation is promising but more work is still needed [13]. Cross sectional imaging, such as CT, may be needed in cases of possible tube misplacement mimics.

Treatment & prognosis

The National Health Service in the UK has deemed enteric tube misplacement a "never event" due to its ubiquity and has extensively researched ways to prevent such events [10]. Even when the tube is placed correctly there are still other morbidity and mortality concerns with enteric tube placement such as epistaxis, refeeding syndrome, and sinusitis [6,14,15].

CONCLUSION

Knowing what normal and abnormal enteric tube placement looks like on chest radiography is critically important to prevent significant patient morbidity and mortality.

TEACHING POINT

Determining proper enteric tube placement is of the utmost importance, as delay in diagnosis can be life threatening and lead to increased risk of morbidity and mortality. On chest radiographs the findings of tube misplacement can be subtle and must be differentiated from common mimickers.

QUESTIONS

Question 1: What is the gold stand for evaluating tube malposition?

1. Clinical signs and auscultations
2. Point of care Ultrasound
3. Capnography
4. Chest Radiograph (applies)
5. Electromagnetic tracings

Explanation: [Chest radiography is the current gold standard to confirm tube placement. Other newer but less ideal ways to confirm enteric tube placement include pH, capnography, and electromagnetic tracings. Use of clinical signs and auscultation is not accurate in determining correct enteric tube placement.] [New research on point-of-care ultrasound for enteric tube confirmation is promising but more work is still needed.]

Question 2: How long should one wait in between placing a gastrotomy tube and an enteric tube to prevent gastrocutaneous fistula in most cases?

1. 12 hours
2. 24 hours (applies)
3. 36 hours
4. 48 hours
5. You can never place an enteric tube after placing a gastrotomy tube

Explanation: [Gastrocutaneous fistula formation typically occurs following gastrostomy tube placement. After twenty-four hours following removal of a gastrostomy tube, the fistula usually closes. For this reason, it is recommended to wait twenty-four hours between gastrostomy tube removal and enteric tube placement.]

Question 3: All the following are common mimickers tube malposition EXCEPT:

1. Hiatal Hernia
2. Anatomic Variations
3. Sutures
4. They all are common mimickers (applies)
5. None of them are common mimickers

Explanation: [[A]n enteric tube in a hiatal hernia (Figure 13) can look to be in the left lower lobe bronchus.] [Other mimickers include lung sutures (Figures 14), and anatomic variations (Figure 15).]

Question 4: Which of the following is most associated with increased risk of intracranial malposition?

1. Skull surgery or skull trauma (applies)
2. Long term tube placement
3. Patient gender
4. Diabetes
5. Prior tube placement

Explanation for question 4: [Skull surgery or skull trauma, especially a basilar fracture, increases the risk of this malposition.]

Question 5: How do you differentiate bronchus misplacement from pleural space misplacement?

1. Enteric tube in the in the pleura tend to be more lateral (applies)
2. Enteric tube in the in the pleura tend to be more medial
3. Enteric tube in the in the pleura tend to be more superior
4. Enteric tube in the in the pleura tend to be more inferior
5. There is no way to tell them apart

Explanation: [While it can be hard to differentiate the pleural space from the bronchus on radiography, an enteric tube in the pleural space will tend to be more lateral than a tube in the bronchus.]

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FIGURES

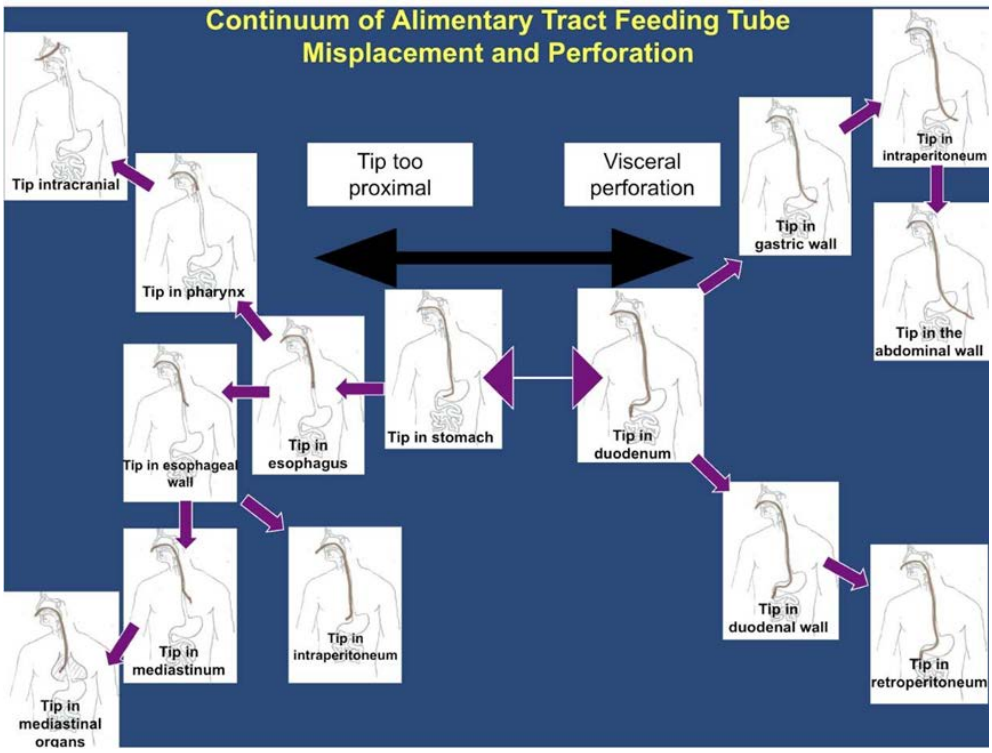

Figure 1: Continuum of Alimentary Tract Feeding Tube Misplacement and Perforation

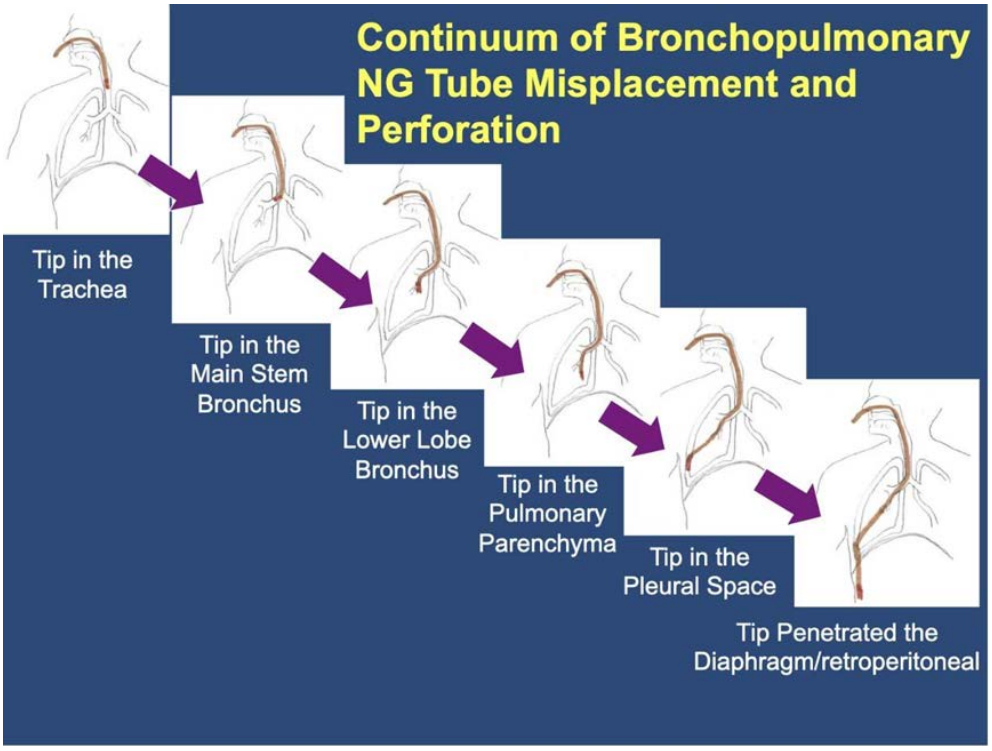

Figure 2: Continuum of Bronchopulmonary NG Tube Misplacement and Perforation

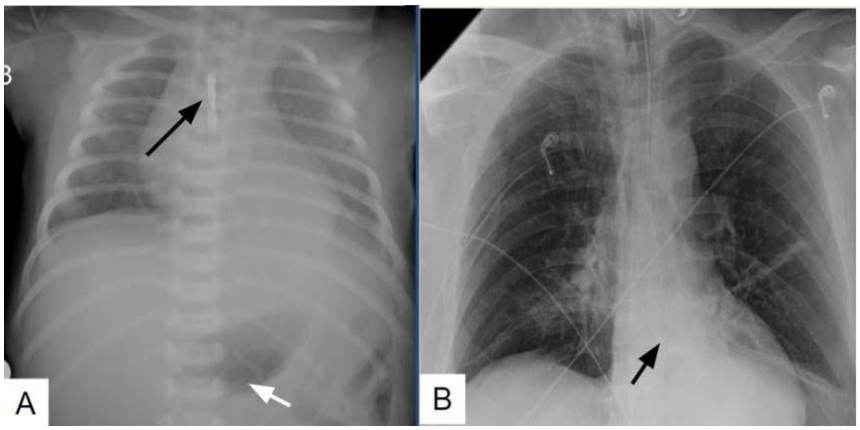

Figure 3: 6-year-old male with esophageal misplacement. FINDINGS: (A) Feeding tube is looped in the stomach (white arrow) resulting in a tip within the upper esophagus (black arrow). In another patient (B) the enteric tube is seen above the diaphragm consistent with an esophageal misplacement (black arrows) TECHNIQUE: Anterior posterior chest radiographs of two patients. 56kV 200mA and 95kV 500mA respectively.

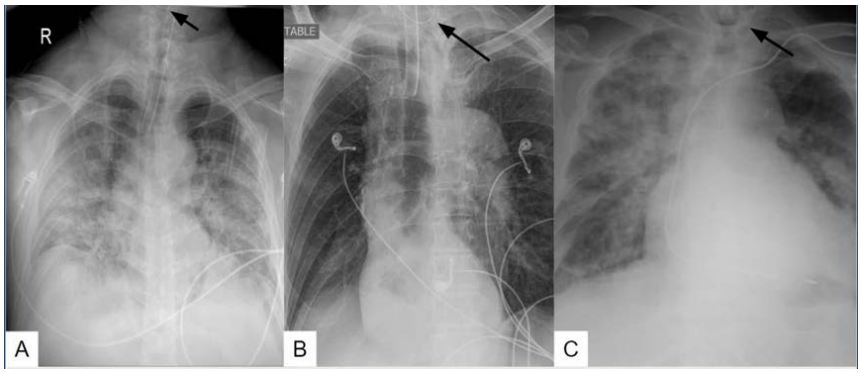

Figure 4: 75-, 76-, and 56-year-old male patients with pharyngeal misplacement. FINDINGS: There is coiling (black arrows) of the (A & B) enteric tube and the (C) feeding tube into the pharynx. These tube malpositions can usually be corrected without complications. TECHNIQUE: Multiple anterior posterior chest radiographs 90kV 250mA, 90kV 300mA, and 95kV 400mA respectively.

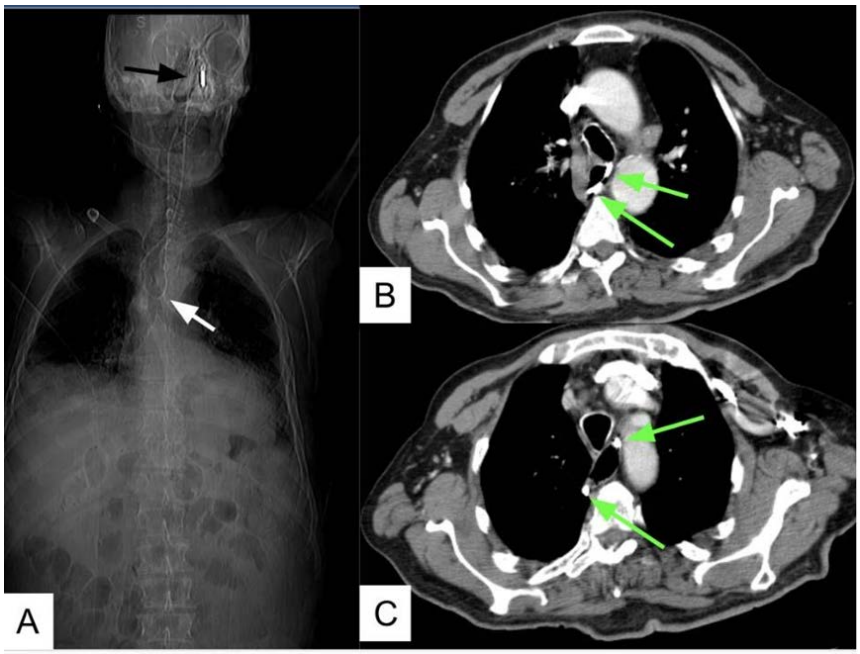

Figure 5: 87-year female with intracranial malposition. FINDINGS: There is coiling of the tube in the esophagus (white arrow) with the tip in the nasopharynx (black arrow) (A). (B and C) The two segments of the tube are visualized (green arrows). TECHNIQUE: CT scout imaging and portal venous phase contrast-enhanced axial CT of the chest 120kV 250mA in soft tissue window with 5mm slice thick cuts and 120 cc of intravenously administered Omnipaque 300.

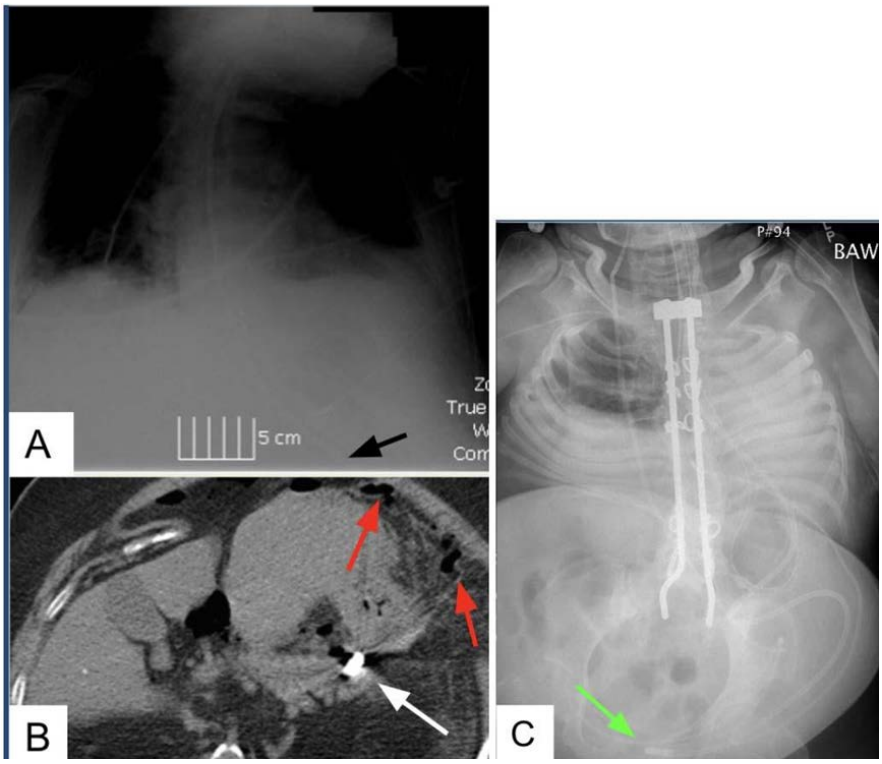

Figure 6: 8-year-old female with gastric perforation. FINDINGS: (A) A feeding tube is seen extending below the left hemidiaphragm (black arrow). (B) Extraluminal air bubbles (red arrows) surrounding the extraluminal radiopaque tip (white arrow) are consistent with gastric perforation by the tube. (C) Different patient with gastric perforation by a feeding tube and tip in the pelvis (green arrow). TECHNIQUE: CT scout frontal chest and abdomen radiograph 90kV 550mA, Axial noncontrast abdominal CT 120kV 350mA in soft tissue window with 5mm slice thick cuts, and 1 view chest and abdomen radiograph 56kV 250mA

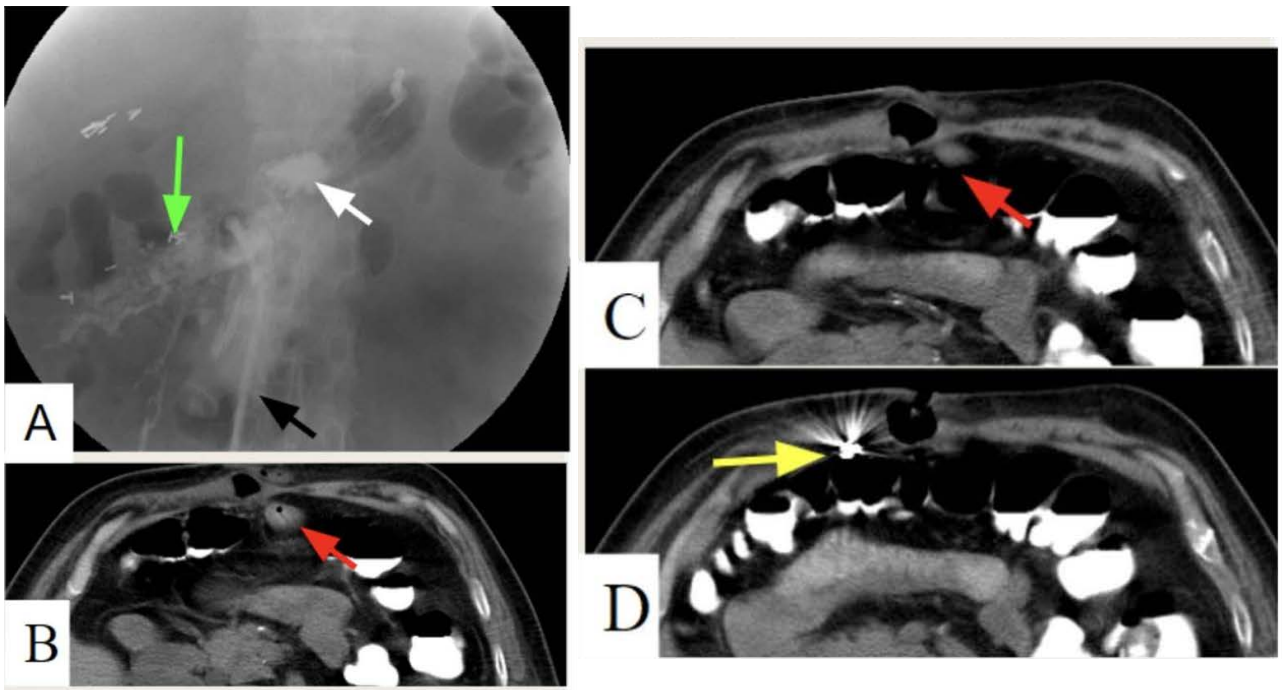

Figure 7: 64-year-old male with gastrocutaneous fistula. FINDINGS: (A) Contrast injection is seen through the PEG (black arrow). A small amount of contrast is pooling in the stomach (white arrow). Extraluminal contrast appears as an irregular collection (green arrow). Subsequent imaging (B-C) shows the stomach tethered to the anterior abdominal wall (red arrows) with the PEG tip (D) in the abdominal wall (yellow arrow) extending through a gastrocutaneous fistula. TECHNIQUE: Fluoroscopy radiograph 80 kV 3mA and sequential axial noncontrast abdominal CT 120kV 300 mA with 5mm slice thick cuts and 25 mL of rectally administered Omnipaque 240.

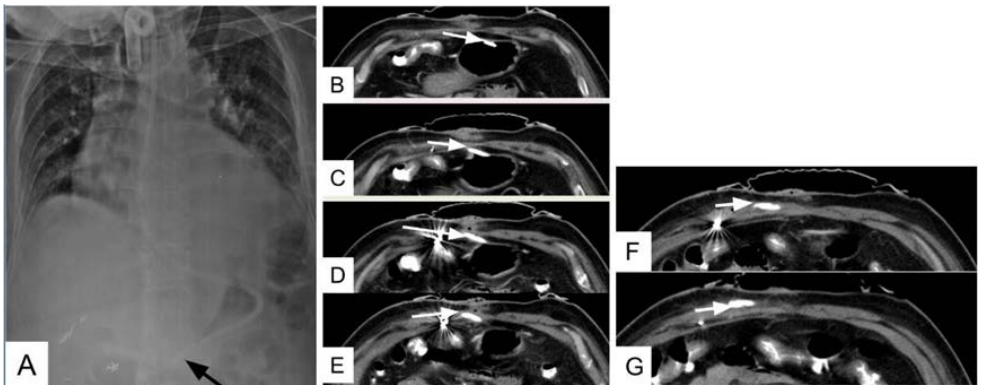

Figure 8: 64-year-old male with gastrocutaneous fistula. FINDINGS: (A) An apparently appropriately positioned feeding tube is seen with the tip overlying the gastric antrum (black arrow). Subsequent imaging (B-G) reveals a feeding tube exiting the stomach (white arrow) into a fistulous tract in the anterior abdominal wall. TECHNIQUE: CT scout image 90kV 400mA and sequential axial noncontrast CT images of the abdomen 120kV 300mA in soft tissue window with 5mm thick cuts and 25 mL of rectally administered Omnipaque 240.

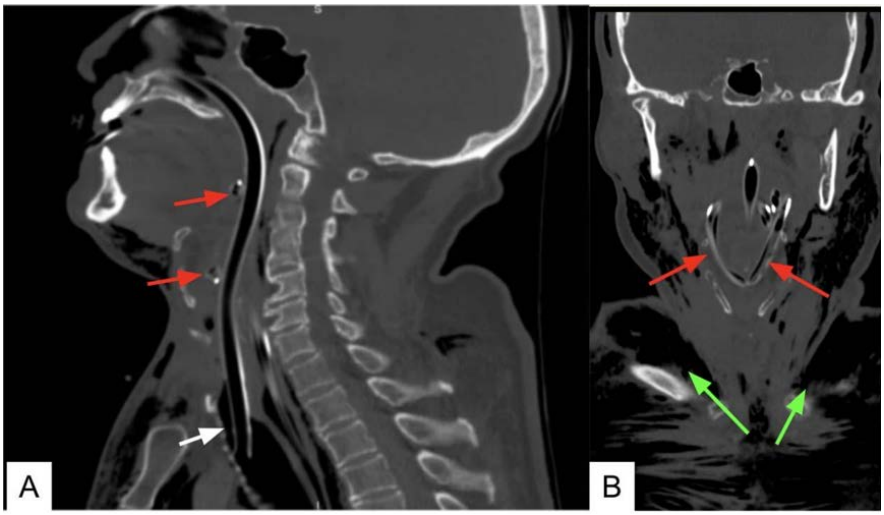

Figure 9: 43-year-old male with laryngotracheal misplacement. FINDINGS: (A&B) A nasogastric tube is seen coiling in the larynx (red arrows) anterior to the endotracheal tube (white arrow). Also noted is extensive soft tissue emphysema (green arrows). TECHNIQUE: Noncontrast sagittal and coronal CT images of the neck 100kV 200mA with 3.5mm cuts in bone window.

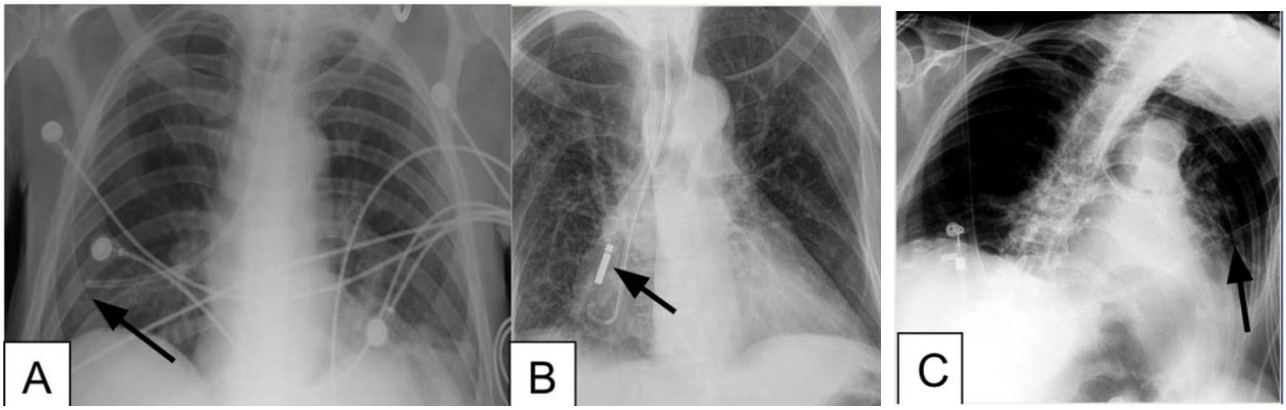

Figure 10: 80-year-old female, 73-year-old male and 36-year-old male with pulmonary parenchymal malposition. FINDINGS: The feeding tube is extending into the right lung parenchyma (A & B) causing injury to the parenchyma. While less common, there can also be misplacement in the left lung parenchyma (C). TECHNIQUE: Multiple anterior posterior chest radiographs 90kV 250mA, 100kV 300mA, and 95kV 350mA respectively.

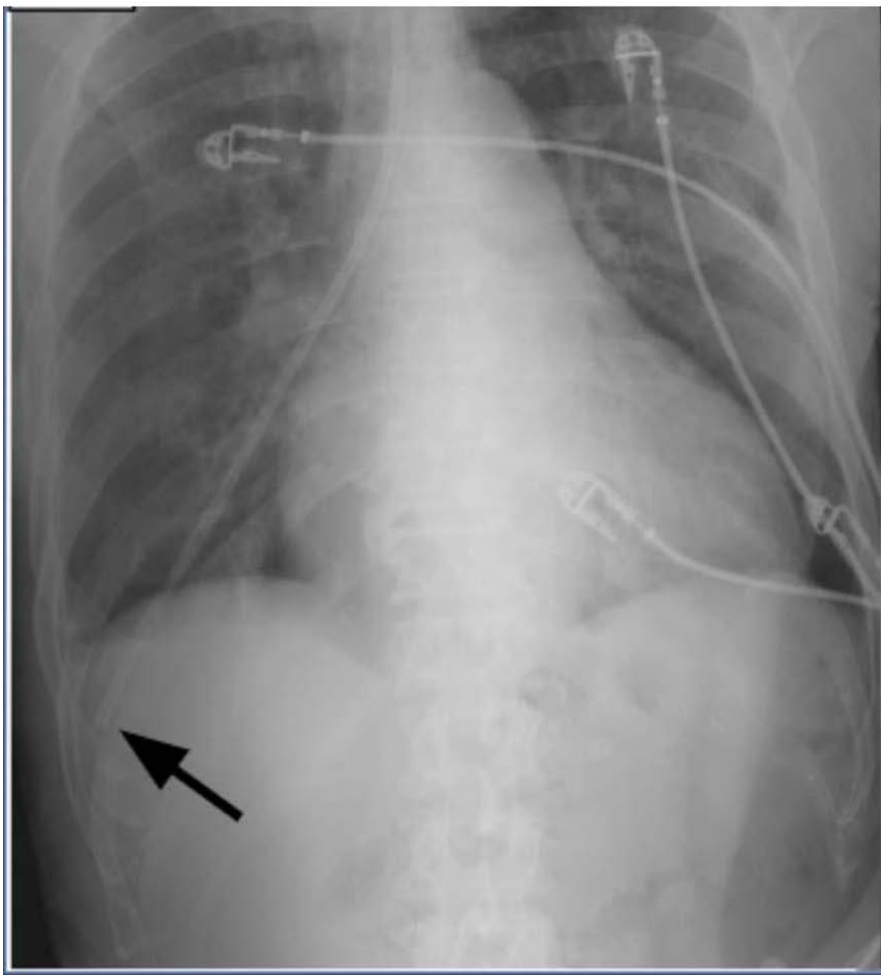

Figure 11: 46-year-old female with pleural misplacement. FINDINGS: Right intrapleural tube misplacement (black arrow) with adjacent blunting of the costophrenic angle concerning for pleural effusion. TECHNIQUE: Anterior posterior chest radiograph 95kV 450mA.

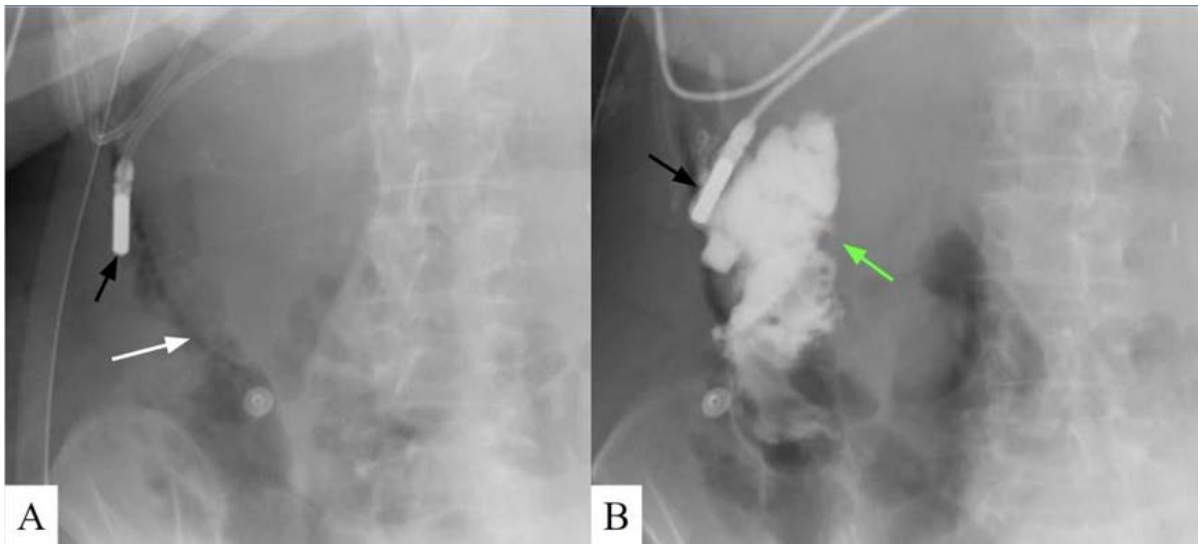

Figure 12: 72-year-old male with retroperitoneal misplacement. FINDINGS: A prior chest radiograph (not included) showing a feeding tube coiled over the right hemithorax with radiopaque tip below the right hemidiaphragm. (A) Air (white arrow) followed by (B) water soluble contrast (green arrow) were injected through the tube. This confirmed retroperitoneal location of the tip (black arrow). The tube was removed under fluoroscopic guidance without subsequent complications. TECHNIQUE: Fluoroscopy radiographic images 80kV 3mA

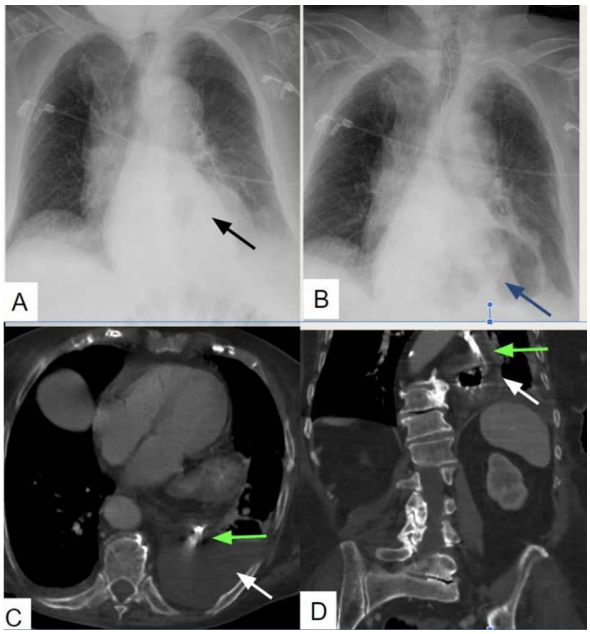

Figure 13: 42-year-old male with hiatal hernia as a malposition mimic. FINDINGS: (A) Enteric tube is seen above the diaphragm (black arrow) concerning for a possible left lower lobe bronchus malposition. (B) This does not improve after advancement of the enteric tube (blue arrow). (C&D) The questioned malpositioned tube (green arrow) is actually within a hiatal hernia (white arrow). TECHNIQUE: Portable anterior posterior chest radiographs 100kV 400mA and 100kV 350mA respectively as well as axial and portal venous phase coronal CT images at the level of the diaphragm 120kV 300mA in bone window with 5mm thick cuts and 120cc of intravenously administered Omnipaque 300

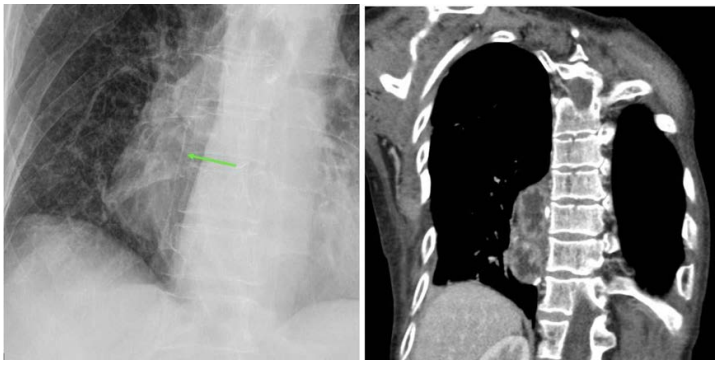

Figure 14: 61-year-old male with lung sutures as a malposition mimic. FINDINGS: A linear dense line (green arrow) is seen in the area of the trachea. This was found to be sutures from a gastric pull-through mimicking an enteric tube. TECHNIQUE: Posterior anterior chest radiograph 95kV 350mA and portal venous phase coronal CT of the chest 120kV 200mA in soft tissue window with 5mm thick cuts and 120cc of intravenously administered Omnipaque 300.

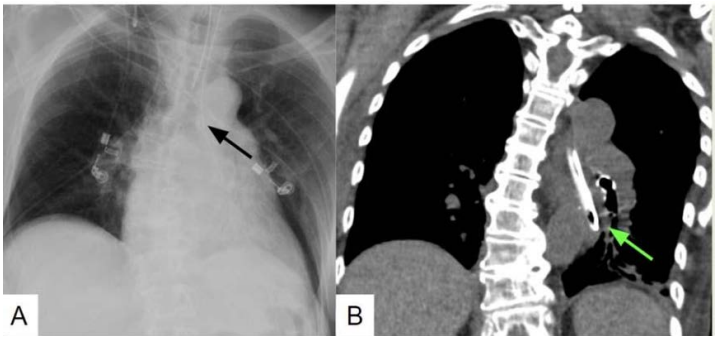

Figure 15: 99-year-old male with anatomic variation as a malposition mimic. FINDINGS: (A) An enteric tube is seen with tip and side hole apparently overlying the lung (black arrow). (B) The tube was shown to be in a tortuous esophagus. (green arrow). TECHNIQUE: Portable anterior posterior chest radiograph 90kV 300mA and noncontrast coronal CT chest 120kV 200mA in soft issue window with 5mm thick cuts.

KEYWORDS

Enteric tube, chest x-ray, misplacement, emergency radiology, radiography