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Negative results - Thoracic general

Thoracic complications of nasogastric tube: review of safe practice

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Abstract

Objective: Insertion of a nasogastric tube, though a common clinical procedure, can produce unexpected complications. We sought to analyse the procedure, and explore means to improve its safety. ***Methods***: We present a case with a thoracic complication. We review the English literature for the range of complications, and collate all available clinical tests used to confirm enteric placement. ***Results***: We discuss the short-comings of the usual clinical tests and emphasise the more recent, but less mainstream, procedures that introduce more objectivity to the enteric tube placement. ***Conclusions***: We provide summary points to guide the clinician in everyday practice.

Keywords: Nasogastric tube; Enteral feeding; Fine-bore feeding tube

1. Introduction

1.1. 'Grains over veins'

The intestinal tract can influence the outcome of critically ill patients [1]. It is the largest lymphoid organ in the body. Enteral feeding increases blood flow to the gut and maintains mucosal integrity, preserves the enterocyte gut-blood defence barrier, reduces translocation of bacteria and enhances its role as an immune organ. Immune enhancing diets containing glutamine appear to reduce the increase in mucosal permeability and also have anti-inflammatory effects. Enteral nutrition also prevents atrophy of the intestinal villi and improves substrate utilisation. These factors make enteral feeding an essential component in recovery from illness, and has precedence over parenteral nutrition.

The nasogastric tube has often been either the subject of court battles defining the ethical right of a patient to die [2] without this 'life-saving or prolonging' tube or as an instrument highlighting medical errors [3]. The innocent looking nasogastric feeding tube can be a source of intrigue when an unexpected complication arises. There is an element of 'blindness' to the usual insertion technique. We present the evidence-base for maximising its safety.

2. Materials and methods

Figs 1 and 2 from our files, serve to illustrate such a complication.

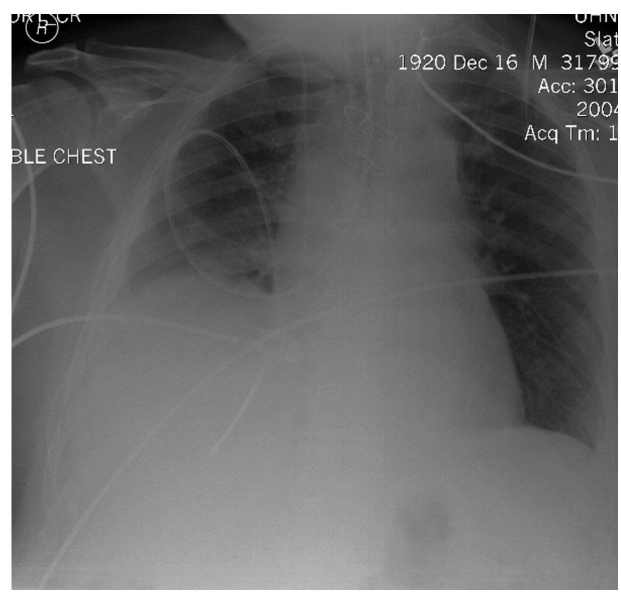

Fig. 1. Nasogastric tube, in the right pleural cavity. There is no immediate pneumothorax.

An 80-year-old patient underwent coronary artery bypass surgery. He required an extended period of ICU stay for ventilatory support. The patient had been on long-term steroids for a chronic obstructive airway disease. A nasogastric tube was inserted because of its proven enteral benefits. Checking the X-ray film showed the NG tube to be in the right pleural space (Fig. 1). There was no obvious immediate pneumothorax. The tube was removed immediately. A repeat chest X-ray taken 2 h later, showed a right

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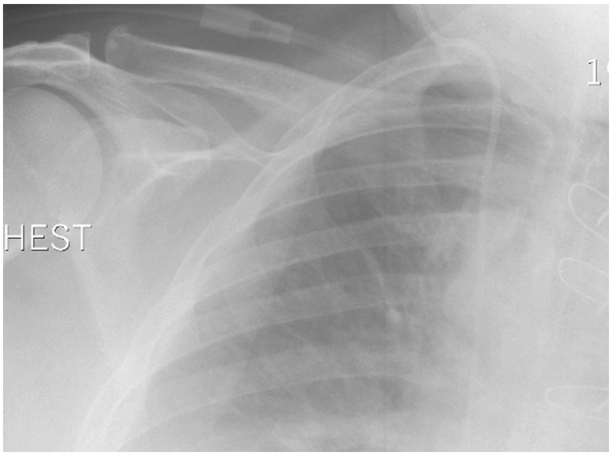

Fig. 2. The second X-ray taken after 2 h shows the presence of an apical right pneumothorax.

apical pneumothorax (Fig. 2). It did not worsen and did not require a chest drain. The patient made a full recovery and was discharged.

We reviewed the English literature using PubMed and Medline Databases with the emphasis on thoracic complications. We looked at the specific anatomic and patient factors that contribute to a misadventure, out of the enteric route. We sought to explore methods that introduce 'objectivity', to guide the clinician during this common procedure.

3. Results

Fine bore nasoenteric tubes have been in use for over two decades.

Our literature review reveals various and unusual complications associated with their use. Reported complication rates vary widely from 0.3% to 8%. For the purpose of providing the complete picture, we outline below both thoracic and non-thoracic misadventures. We go on to discuss only the thoracic complications in this review.

3.1. Thoracic complications

3.1.1. Tracheobronchopleural complications [4]

1. Bronchial placement leading to atelectasis, pneumonia and lung abscess
2. Bronchial perforation and pleural cavity penetration
   - Pneumothorax
   - Isocalothorax (enteral feed hydrothorax)
   - Empyema and Sepsis
   - Pleural knotted tube [5]
   - Pulmonary hemorrhage
3. Bronchial suture line entrapment, following lobectomy [6]

3.1.2. Intravascular penetration

1. Erosion into Retroesophageal aberrant right subclavian artery [7]
2. Right Internal Jugular vein to right atrium [8]

3.2. Non-thoracic complications

3.2.1. Enteral complications

1. Tube knotting and impaction
   - In the posterior nasopharynx [9]
   - Beyond the pylorus
2. Tube double backing and kinking
3. Tube obstruction and rupture with syringing
4. Tube breakage
5. Enteric perforation
   - Esophageal (and mediastinitis)
   - Duodenal

3.2.2. Intracranial entry

1. Following repair of choanal atresia and transnasal trans-sphenoidal surgery [10]
2. Following maxillofacial trauma [11]

Rassias reported a 2% incidence of tracheopulmonary complications among 740 tube insertions and 0.3% died from the complications [12]. In a Medline review of 106 pulmonary misadventures by that author, pneumothoraces accounted for approximately 60% of complications. Fifty percent of these required a chest drain. In 15%, the misdirected bronchial tube did not cause any complications. One patient died of a respiratory arrest on tube withdrawal [4].

In certain circumstances, a pulmonary complication can be particularly significant. Kolbitsch reported a pneumothorax from a feeding tube in a patient with bilateral lung transplantation [13]. Though this patient recovered with an additional chest drain, this could potentially have disrupted the bronchial anastomosis with disasterous consequences.

Granier reported the incorporation of the tube tip in a bronchial suture line following right lower lobectomy. The nasogastric tube had been inserted prior to thoracotomy, following endotracheal intubation. Postoperatively, attempted tube withdrawal elicited fits of coughing. A fibreoptic bronchoscopy could not free it and a further thoracotomy was required to withdraw the tube [6].

Knots form in the stomach when excess tubing is advanced, allowing it to loop back on itself. During tube removal, there should be a low threshold for aborting the procedure if any resistance develops. The nasopharyngeal knot is a case in point [9]. An extreme quirk of probability is the knotted tube in the pleural cavity, requiring thoracoscopic removal [5].

The nasogastric tube has also been reported to have penetrated the right internal jugular vein at the height of the soft palate and passed down the superior vena cava into the right atrium. The tube followed the concave contour of a deviated nasal septum and ultimately perforated the lateral oropharyngeal wall [8]. The blood in the tube aspirate was assumed to be from a gastric bleed. Continued free drainage led to hemodynamic collapse. The eventual diagnosis was made on computerised tomography.

Feeding tubes should be avoided in those known to have an aberrant right subclavian artery. Fatal hematemesis has been reported [7].

4. Discussion

4.1. Analysis of the risk factors

A combination of factors synergistically lead to a misplacement.

4.1.1. Anatomy of tube insertion

Traditionally the nasogastric tube is inserted blindly. Once the tube is at 15–20 cm, the head is flexed bringing the chin closer to the chest. This manoeuvre narrows the trachea and opens the esophagus. Levy recommended the rotation of the patient's head towards either shoulder. This causes the deviation of the feeding tube to tip away from the midline laryngeal opening [14].

Assuming the median distance from the anterior nasal spine to the cricopharyngeus (tracheoesophageal junction) to be about 20 cm, the oesophagus to be 25 cm long and given that the tip of a nasogastric tube should lie 10 cm below the gastro-oesophageal junction, the nasogastric tube should ideally be secured at the 50 to 60 cm mark at the nasal vestibule [15]. Alternatively, the distance from the nose to the pinna and from the pinna to the xiphoid process, and adding another 5 cm, will place the tip in the fundus [9]. The 'victorious' placement of the tube to its full length is not a good practice.

4.1.2. Associated risk factors

The endotracheal tube, instead of deflecting the feeding tube, may actually increase the risk of pulmonary entry by preventing glottic closure and inhibiting swallowing. The stylet-stiffened fine bore tube is also able to squeeze past the low-pressure cuffs. Altered mental status and sedation prevent an effective cough reflex. One episode of misdirected tube also increases the risk of further misplacements.

Tube designs influence its safety. Current polyurethane fine bore tubes have evolved from the earlier use of latex, silicone and polyvinylchloride.

Polyurethane does not stiffen, embrittle or biodegrade in vivo. This reduces the risk of enteric perforation and tube cracks. Polyurethane is very flexible and has a larger lumen to wall thickness ratio. Weighted tubes currently use tungsten, rather than mercury. Leakage of mercury via tube cracks and even systemic absorption and toxicity have been reported [16]. The weighted tube tip gravitates preferentially to the posterior oropharynx, pointing it towards the esophagus, and lessens misplacement [17].

4.2. Common enteric-placement 'confirmatory' tests

4.2.1. Traditional soft clinical signs

The easy placement of the tube to its full length, the absence of coughing, visual inspection of tube aspirate, and a positive epigastric auscultation are not always reliable confirmatory signs of correct tube placement. Bubbling of the tube under water, as a positive sign of pulmonary misplacement, has been observed occasionally with the tube in the stomach. Plugging of the port-holes by a snug smaller bronchus yields a false negative bubble sign. Even phonation may be unaffected by a small fine bore tube in the bronchus as they do not cause sufficient separation or mal-apposition of the vocal cords.

4.2.2. Air insufflation and epigastric auscultation

This has been the traditional sign of gastric placement. However, good thoracoabdominal sound transmission can lead to misinterpretation even with pulmonary misplacement. Benya found a 20% false gastric confirmation by auscultation [15]. Duthorn recommends an initial negative blood aspiration test before air insufflation [11]. Air would be fatal in an unrecognised intravascular placement! Air insufflation or an open 'sucking' tube can also produce a pneumothorax in a pleural misplacement.

4.3. Techniques with improved objectivity and safety

4.3.1. Roubenoff and Ravich two-step protocol

In 1989, Roubenoff and Ravich proposed the two-step protocol for the nasogastric tube insertion [4]. Here the tube is initially advanced blindly to 30 cm and the position verified by an X-ray. This initial distance restriction is crucial to prevent a pulmonary complication by keeping an already misdirected tube away from the more distal smaller bronchi or the lung, where a perforation is most likely. At the same time, the 30 cm length allows it to reach only the proximal mainstem bronchi so that the abnormal curve of deviation away from the midline will be picked up on the X-ray and the procedure halted. If the X-ray shows a midline tube, this confirms its position to be in the esophagus and the tube can be further inserted to the optimum length of 50 cm and confirmed with the second X-ray.

The 2-step insertion procedure eliminates potential complications, but exposes the patient to two X-rays, it is time consuming and is not routinely practised.

4.3.2. pH of aspirate and bilirubin

Mean pH levels in the lung (7.73) and intestine (7.35) are significantly higher than in the stomach (3.90). An infected pleural or respiratory secretion can, however, yield an acidic pH and a false positive for a gastric position. Achlorhydria and potent anti-acid medications give misleading alkaline pH in the stomach.

Mean bilirubin levels in the lung (0.08 mg/dl) and stomach (1.28 mg/dl) were significantly lower than in the intestine (12.73 mg/dl). Bilirubin can now be measured with a colorimetric visual scale teststrip.

Metheny combined these 2 markers, to propose a more predictive, yet simple bedside test [18].

- A pH less than 5 and bilirubin less than 5 mg/dl identified 98% of gastric sites.
- A pH greater than 5 and a bilirubin less than 5 mg/dl identified 100% of the respiratory sites.
- A pH greater than 5 and bilirubin greater than 5 mg/dl identified nearly 88% of the intestinal sites.

However, this method only confirms the complication, but does not avoid it from occuring.

4.3.3. Capnography

The presence of carbon dioxide (CO_2) is a proven surrogate marker for the pulmonary environment. Incorporating capnography into Roubenoff and Ravich's 2-step concept, could potentially increase its practical utility. Araujo reported excellent initial results with a compact, disposable colorimetric end-tidal CO_2 detector [19]. Here, the Capnometer confirms the tube position at the crucial 30 cm position. The capnometer was able to detect enough CO_2 coming out of the feeding tube, even with the guide wire in place. The tube is further inserted to 50 cm with a single radiologic confirmation of the final placement. They reported a 100% specificity and a 100% sensitivity rate among 53 insertions.

4.3.4. Endoscopic

Recent advances in endoscopic technology have led to the production of small-diameter (5–6 mm) upper gastrointestinal tract video flexible endoscopes that can be passed via the nose, rather than the mouth, into the retropharynx and then down the esophagus. The endoscope has a channel which can be used for guidewire placement. The feeding tube is fed over the wire. This can be used in the difficult, or prior failed, or complicated attempts. It is very useful in patients with gastroparesis where the gastric site is less satifactory and where nasojejunal feeding tube positioning is preferred [20].

5. Conclusion

The main advantage of the newer methods is the ability to eliminate the 'blindness' of the insertion. It can therefore prevent respiratory complications. However, these techniques are not routinely used and perhaps are not in the 'mainstream know-how'. We wish to emphasize how deceptively atraumatic, a misguided-insertion might feel, even to the hands of a well-experienced surgeon or clinician.

6. Summary points

1. Traditionally, nasogastric tubes have been inserted blindly.
2. The X-ray remains the gold standard to verify the correct placement.
3. Traditional bedside 'confirmatory' signs of gastric placement may not be reliable and should not be used as a substitute to the X-ray.
4. The check X-ray, detects a complication, but does not prevent it.
5. Tracheobronchial complications are not uncommon with blind nasogastric tube insertions.
6. Pneumothorax is the commonest pulmonary complication.
7. The 2-step insertion is the best way to prevent complications.
8. Initial 30 cm is the crucial damage limiting distance, as it is at the tracheoesophageal transition zone.
9. The final nasogastric-position is ideally at 50–60 cm from the incisor teeth.
10. Insertion of excess tubing is to be avoided.
11. Tracheal entry can be detected using small, disposible capnometers.
12. Newer nasoendoscopes with guidewire exchange, are patient friendly and are ideally suited to the high risk patient.
13. High risk patients include:
    - a Intubated and sedated
    - b Elderly
    - c Mentally obtunded
    - d Following Lung transplantation
    - e Repeated attempt after earlier pulmonary misadventure

A paradigm shift from the traditional to the more discerning recent methods is well worth the while, in view of the increasing complexity of patients dealt with, coupled with the now better understood benefits of enteral nutrition. This concerns surgeons and physicians alike. A purposeful insertion backed up by a high index of suspicion is certainly better than cure in this population of patients.

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