Respiratory Complications Associated with Insertion of Small-Bore Feeding Tube in Critically Ill Patients

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Small-bore flexible feeding tubes decrease the risk of ulceration of the nose, pharynx, and stomach compared with large-bore and more rigid tubes. However, small-bore feeding tubes have more respiratory system complications, such as pneumothorax, hydropneumothorax, bronchopleural fistula, and pneumonia, which are associated with significant morbidity and mortality. Thus, it is important to confirm the correct position of feeding tubes. Chest X-ray is the gold standard to detect tracheal malpositioning of the feeding tube. We present three cases in which intubated patients exhibited an altered mental state. An assistant guide wire was used at the insertion of small-bore feeding tubes. These conditions are thought to be potential risk factors for tracheobronchial malpositioning of feeding tubes.

Key Words: critical care; feeding, tube; pneumothorax.

Feeding tubes are used for proper nutrition and medication in many intensive care units (ICUs). In the past, large-bore, more rigid nasogastric tubes were used, but more recently, small-bore, flexible feeding tubes have been employed to decrease the risk of ulceration of the nose, pharynx, and stomach.[1] However, more complications concerning the respiratory system have been reported for small-bore feeding tubes compared with large-bore ones. Such complications include pneumothorax, hydropneumothorax, bronchopleural fistula, atelectasis, empyema, pneumonitis, and pneumonia. These complications are also associated with significant morbidity and mortality.[1-4] Thus, we report three cases of respiratory malposition and complications associated with the insertion of small-bore feeding tubes and review the methods to prevent these complications and confirm the exact position of the feeding tube.

CASE REPORT

1) Case 1

A 62-year-old male patient visited our hospital with hematochezia; he had been taking methylprednisolone due to antineutrophil cytoplasmic antibody (ANCA)-associated vasculitis. He was admitted to the medical ICU because of severe metabolic acidosis, hyperkalemia, and shock. A mechanical ventilator was applied after intubation because of type 4 respiratory failure (hypoperfusion to respiratory muscle due to septic shock). A feeding tube was inserted 6 days after admission and the patient still had an endotracheal tube. Insertion of the feeding tube was very difficult because the patient was irritable and uncooperative, exhibiting severe agitation. The position of the tube could not be confirmed because bubbling sounds during air insufflation were not auscultated in the epigastric region. A chest X-ray was taken immediately after insertion of the feeding tube; this revealed that the feeding tube was inserted through the right main bronchus...

into the right lung (Fig. 1a). The feeding tube was immediately removed and then reinserted. A second chest X-ray was taken after reinserting the feeding tube (Fig. 1b). Pneumothorax was detected and a chest tube was inserted immediately. Other than pneumothorax, no other complication was detected. The patient gradually improved and the chest tubes were removed; he was then transferred to the general ward. He was discharged without major problems two weeks later.

2) Case 2
A 72-year-old male patient with kidney transplantation due to polycystic kidney disease was admitted to the medical ICU due to sepsis caused by pneumonia and *Pseudomonas bacteremia*. A mechanical ventilator was applied, but weaning off the ventilator was difficult due to stuporous mental state. Twenty days after ICU admission, a feeding tube was inserted and the patient still had an endotracheal tube; the patient had no cough or gag reflex during insertion of the feeding tube due to decreased consciousness. The feeding tube was easily placed and no unusual resistance was encountered. After insertion of the tube, serous-colored fluid was found to be draining into the tube and a chest X-ray was taken to confirm the position of the tube. The chest X-ray revealed that the tube was inserted through the right main bronchus into the right lung, and the tip of tube was located in the right pleural space (Fig. 2a). The tube was immediately removed and reinsertion was attempted. However, this reinsertion
was stopped because serous-colored fluid began to drain into the tube again. A second chest X-ray was performed because the patient’s oxygen saturation had decreased to 88% and his heart rate was elevated at over 130 beats per minute. The chest X-ray revealed right pneumothorax (Fig. 2b) and a chest tube was inserted. The patient gradually improved after intensive treatment and was transferred to the general ward three weeks later. The chest tube was removed four weeks after transfer. The patient was discharged without complications.

3) Case 3
An 81-year-old male patient was admitted to orthopedics with a fracture of the left hip and femur neck due to a fall. Mild dyspnea and hypoxia were observed after admission, and pneumonia, pulmonary embolism, or fat embolism was suspected. After bipolar hemiarthroplasty operation on the left hip, the patient was transferred to the ICU because his oxygen saturation decreased (respiratory failure type 1) and a ventilator was applied after intubation. There was no evidence of pulmonary thromboembolism on chest computed tomogram. Two weeks later, septic shock caused by pneumonia occurred and a stuporous mental state due to septic encephalopathy was detected. Tracheostomy was carried out due to continuous weaning failure. Eight days after the tracheostomy, a feeding tube was inserted. No unusual resistance was encountered during feeding tube insertion; positioning of the tube was confirmed by air insufflation (30-50 ml), auscultation of bubbling sounds in the epigastric region, and aspiration of 4-5 ml of a light yellow fluid from the tube. We thought the feeding tube was in the correct position and started tube feeding, but the residual was found to be over 360 cc after 3 hours, and then tube feeding was stopped. We performed a chest X-ray immediately and detected the right side hydropneumothorax due to a respiratory tract malpositioning of the feeding tube with pleural perforation in the right inferior lobe (Fig. 3a). The malpositioned feeding tube was immediately removed and a chest tube was inserted (Fig. 3b). However, the patient’s septic shock worsened and he expired due to septic shock and multi-organ failure one week later.

DISCUSSION
Between January 2013 and August 2013, we retrospectively investigated placements of small-bore feeding tubes in order to identify cases of insertion into the tracheopulmonary system. The feeding tube used in all cases was small-bore, flexible feeding tube (COVIDIEN Kangaroo, Entreflex™ Nasogastric Feeding Tubes, 12 Fr, 60 in) and an assistant guidewire was used. During this period, 392 small-bore feeding tubes were placed in a 43-bed multidisciplinary ICU (medical and surgical ICU) at the Samsung medical center. We identified 3 cases (0.77%) where feeding tubes were inserted into the tracheopulmonary system. They suffered a major complication, including one (0.26%) who died from complications directly related to malposition of the feeding tube. Rassias et al.[1] also reported that small-bore feeding tubes were inserted into the tracheopulmonary system in 2% of placement attempts in their prospective study. Overall feeding tube-induced complications such as pneumothorax and hemothorax occurred in 0.7% and complication-
Table 1. Patient characteristics

<table>
<thead>
<tr>
<th>Variables</th>
<th>Case 1</th>
<th>Case 2</th>
<th>Case 3</th>
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<tbody>
<tr>
<td>Sex</td>
<td>Male</td>
<td>Male</td>
<td>Male</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>Septic shock</td>
<td>Sepsis</td>
<td>Septic shock</td>
</tr>
<tr>
<td>Endotracheal tube or tracheal tube</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sedation</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Altered mentality</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Who placed</td>
<td>Physician</td>
<td>Physician</td>
<td>Physician</td>
</tr>
<tr>
<td>Adverse outcome</td>
<td>Pneumothorax (right)</td>
<td>Pneumothorax (right)</td>
<td>Pneumothorax (right), Fed into right pleural space, death</td>
</tr>
<tr>
<td>Therapy</td>
<td>Tube thoracostomy</td>
<td>Tube thoracostomy</td>
<td>Tube thoracostomy</td>
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induced death in 0.3% of cases, respectively. Thus, respiratory system complications are not rare when small-bore feeding tubes are inserted. Nevertheless, these complications have not been reported in Korea.

In our three cases, all patients were intubated (endotracheal or tracheal tube) and exhibited an altered mental state. The clinical characteristics of these 3 patients are summarized in Table 1. In the first case, the insertion of the feeding tube was very difficult because the patient was irritable and uncooperative. In the second and third cases, the patients exhibited a poor response due to decreased consciousness during feeding tube insertion. An assistant guidewire was used in all cases. The complications due to respiratory malpositioning of the feeding tube were pneumothorax, hydropneumothorax, pneumonia, and septic shock in our cases. These complications were associated with significant morbidity and mortality in the third case. All feeding tubes were inserted through the right main bronchus into the right lung in our three cases. The right lung and pleura are most commonly involved because the right main bronchus is more vertical than the left main bronchus.

Generally, decreased mentality is a risk factor for respiratory malpositioning of feeding tubes. Intubation could be thought of as a mechanical barrier; however, the low pressure cuffs of endotracheal or tracheal tubes do not represent a reliable barrier. If an assistant guidewire is used, the small, flexible tube may slide into the trachea by the cuff along the tracheal wall. However, it is very difficult to insert the tube without a guidewire. Critically ill patients with endotracheal intubation and tracheotomy exhibit poor response due to sedation. These conditions have been thought to be potential risk factors for the tracheobronchial malpositioning of feeding tubes.[5-7] The major risk factors for tracheopulmonary malpositioning of feeding tubes might be associated with endotracheal intubation or tracheostomy and decreased mentality.[1,5] In our cases, all patients also had altered consciousness and were intubated (endotracheal or tracheal tube).

Conventional methods of confirming the position of the tube are commonly used, including auscultation of bubbling sound in the epigastri c region during air insufflation and aspiration of gastric fluid. However, these conventional methods are not useful in identifying respiratory malpositioning of feeding tubes.[1-3] Kolbitsch et al.[4] reported a similar case to ours. In this case, the patient was under sedation and mechanical ventilation. The feeding tube was easily inserted and no unusual resistance was encountered. Then, the physician confirmed the positioning using the conventional methods (auscultation during air insufflation, aspiration of gastric fluid, etc.). However, on performing a chest computed tomogram, it was found that the feeding tube had passed the tracheal tube; it had been inserted into the right inferior lobe bronchus and ended in a capsuled pneumothorax. Theoretically, these conventional methods could be dangerous and induce lung damage; if a feeding tube is placed directly into the lung parenchyma and then air is injected in order to check the positioning of the tube, it is possible to provoke a local airway disruption and a pneumothorax.[1] Therefore, we need another method of checking the position of feeding tubes and preventing complications of the respiratory system.

To confirm the position of feeding tubes, measures of end-tidal carbon dioxide concentration (ETCO₂), gastric pH, and chest X-ray have been suggested.[2,4,5,8-10] Chest X-ray is the gold standard to detect tracheal malpositioning. Chest X-rays are often employed to verify the position of feedings tube in many ICUs, but caution should be employed when confirming the correct position of the tube. Ru Luo et al.[5] suggested looking at the following four signs that indicate the correct position of the feeding tube: 1) the tube path follows the esophagus; 2) the tube bisects the carina; 3) the tube crosses the diaphragm in the middle; and 4) the tip is below the left hemi-diaphragm.

Unfortunately, none of the methods used to check the position after inserting the tube prevent respiratory complications during
insertion of the tube. Thus, other methods of preventing the tube from entering the respiratory system are needed.[2] Several approaches have been developed, such as fluoroscopy-, laryngoscopy-, and endoscopy-guided insertion. However, all of these techniques have the drawback of increasing the cost and time of insertion; moreover, they require the availability of assistance from specialists.[1]

Roubenoff and Ravich[11] have suggested a two-step technique for the placement of feeding tubes in high-risk patients. In this method, the feeding tube is placed in the esophagus with the tip positioned above the level of the xiphoid and the position is verified with a chest X-ray. If the position is correct, the tube is inserted to the stomach and the positioning is rechecked through a second chest X-ray. After confirmation, the guidewire is removed and feeding is initiated. Roubenoff and Ravich[11] asserted that this two-step technique is an effective method to prevent respiratory malpositioning of the feeding tube, even though the requirement for two chest X-rays is more costly.

The use of capnography was suggested as a new method. Kindopp et al.[2] asserted that this method was used to accurately identify respiratory tract malpositioning of the feeding tube. In this study, the feeding tube was placed either via a nasal or an oral approach to a distance of 30–35 cm, and the position of the tube was verified using capnography. Correct positioning of the tube in the esophagus was confirmed before the feeding tube was inserted completely. The principle of this method is similar to that of the two-step technique. The study also showed that the use of capnography would shorten the insertion time of the tube compared with the two-step technique.

Continuous endotracheal cuff-pressure monitoring can prevent respiratory malpositioning of the tube during gastric tube insertion. In one study, during gastric tube insertion, the cuff pressure was increased to 40 cmH2O to ensure full inflation of the cuff and to maximize the contact area between the tracheal wall and the cuff. Then, an increase in the cuff pressure to more 10 cmH2O would indicate the endotracheal malpositioning of the gastric tube.[3] In this study, the authors suggested that using a method of cuff pressure monitoring (more than 10 cmH2O) resulted in the detection of respiratory malpositioning with 100% sensitivity and specificity; however, in this study, large-bore gastric tubes were used rather than small-bore feeding tubes. Therefore, when using a small-bore feeding tube, the exact cuff pressure that represents endotracheal insertion of tube is not known.

It is not extremely rare for a small-bore feeding tube to be inserted incorrectly into the respiratory system, and respiratory tract malpositioning of the tube can lead to various complications associated with significant morbidity and mortality. Thus, care should be taken when inserting feeding tubes. Decreased consciousness is a significant risk factor for respiratory malpositioning of feeding tubes and the low pressure cuffs of endotracheal or tracheal tubes are not a reliable barrier. Using of guidewire is also significant risk factor. If an assistant guidewire is used, the tube may slide into the trachea by the cuff along the tracheal wall. Thus caution will be needed at using guidewire. Chest X-rays should be employed to verify the position of feedings tube because conventional methods are sometimes not useful in identifying respiratory malposition. Our routine policy for placement of feeding tubes was changed as confirming by chest X-ray. In addition, in order to prevent respiratory tract malpositioning, preventive methods can be used such as capnography, monitoring of the cuff pressure of endotracheal or tracheal tubes, the two-step technique, and so on.

### REFERENCES


