Intensive Care Med (1997) 23: 406–410

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Radiographic detection of intrabronchial malpositions of nasogastric tubes and subsequent complications in intensive care unit patients

Received: 29 November 1995
Accepted: 6 December 1996

Manuscript preparation was supported in part by the Ludwig Boltzmann Institute of Physical and Radiological Tumor Diagnosis

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Abstract *Objective:* The aim of our study was to illustrate the radiographic spectrum of the intrabronchial malposition of nasogastric tubes and subsequent complications, and to discuss the role of radiography in the detection of such malpositions.
Design: Retrospective clinical investigation.
Setting: Tertiary care university teaching hospital.
Patients and methods: We reviewed chest radiographs of 14 intensive care patients with nasogastric tubes malpositioned in the tracheobronchial tree. The site and anatomic location of the malposition were recorded. Complications due to tube malpositioning were monitored on follow-up radiographs and on computed tomographic examinations, which were available in 4 patients.
Results: Nine of 14 nasogastric tubes were inserted in the right and 5 in the left tracheobronchial tree. Tube tips were malpositioned in the lower lobe bronchi (50 %), the intermediate bronchus (36 %), and the main bronchi (14 %). There was perforation of the bronchial system with subsequent pneumothorax in 4 patients. In 4 other patients, pneumonia developed at the former site of the malpositioned tube tip. Radiographic detection of nasogastric tube malpositioning was prompt in 9 patients and delayed in 5 patients.
Conclusions: Whereas clinical signs of nasogastric tube malpositioning in intensive care patients may be absent or misleading, chest radiography can accurately detect nasogastric tube malpositions in the tracheobronchial tree, may prevent complications, and avoid the use of further costly or invasive diagnostic techniques.

Key words Nasogastric tubes · Chest radiography · Bedside · Postprocedural chest radiography · Pneumothorax · Lung infection

Introduction

Nasogastric intubation of intensive care patients carries the risk of tracheobronchial tube malpositioning [1, 2]. The occurrence of serious complications from such a malposition at one of the intensive care units in our hospital prompted a retrospective search for similar misplacements. The aim of this investigation was twofold: first, to show common radiographic patterns of nasogastric tube misplacement in the bronchial tree and its subsequent clinical complications; and, second, to emphasize the role of radiography in the early detection of both nasogastric tube malpositioning and complications of bronchial intubation.

Patients and methods

A computerized search covering an 11-month period (March 1994 to January 1995) gave evidence of the malpositioning of 14 nasogastric tubes in the tracheobronchial tree of intensive care patients. In the same period, 3736 reported intensive care chest radiographs were available for analysis, and approximately 1700 nasogastric tubes had been inserted in intensive care patients in our hospital. The tubes were all small-bore and radio-opaque (Nutrisoft feeding tube, Pfrimmer Nutricia, Erlangen, Germany; Gastroduodenal tube, Unoplast, Hundested, Denmark), and none of the tubes was placed using stiffening guide wires. All tube insertions were performed under the supervision of experienced intensive care personal.

Of the 14 intensive care patients with radiographically documented malpositioned nasogastric tubes in the tracheobronchial

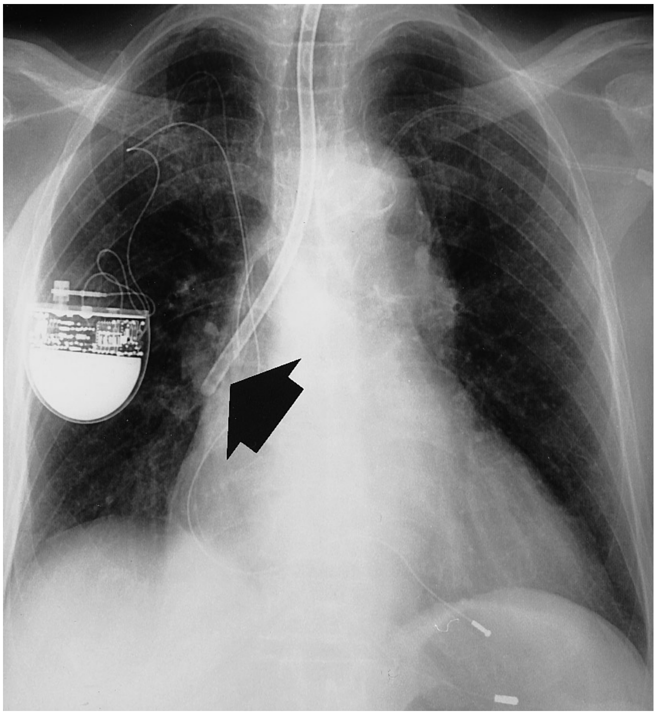

Fig. 1 Supine chest radiograph of an 89-year-old intensive care patient shows nasogastric tube malpositioned in the tracheobronchial tree. The nasogastric tube follows the course of the trachea and abuts in the right main bronchus (arrowhead)

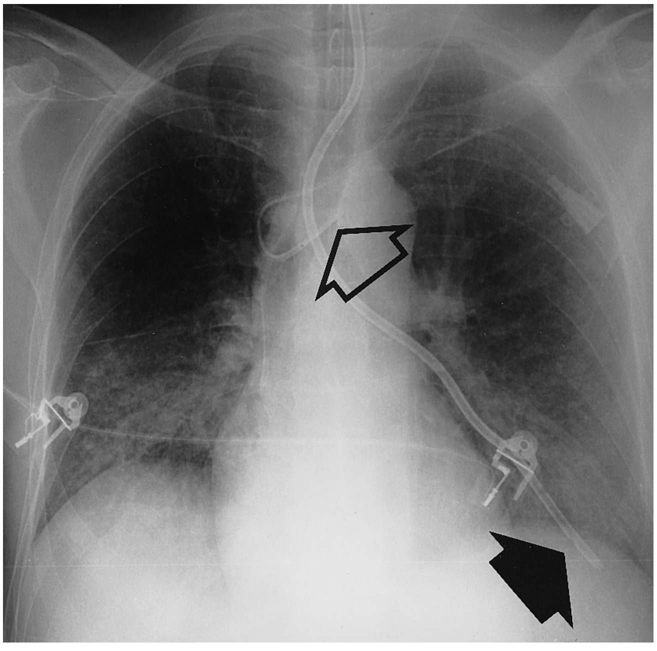

Fig. 2 Supine chest radiograph of a 52-year-old intubated and ventilated intensive care patient demonstrates malposition of nasogastric tube with the tube tip in the left tracheobronchial tree (black arrowhead). Despite the distal position of the tube tip, there is no evidence of pneumothorax. Note the curled tip of the central venous catheter inserted over the left jugular vein (open arrowhead)

tree, 8 were female and 6 were male, with a mean age of 57.1 ± 17.4 years (range 26 to 89). At the time of nasogastric intubation, 8 patients had endotracheal tubes and 1 patient had a tracheostomy tube. Of the 14 malpositioned tubes, 8 were placed by blind insertion and 6 were placed via laryngoscopy.

For all 14 patients supine or semi-erect frontal radiographs were available for analysis. In two patients, additional cross-table lateral views had been obtained. All patients had follow-up radiographs and 4 patients also had computed tomography (CT) of the thorax within a 5-day period following the radiographic detection of the malpositioned nasogastric tubes. Two of the four also underwent fiberoptic bronchoscopy.

The radiographs documenting nasogastric tube malpositioning were analyzed for site and anatomic location of the misplaced tube tip. The nature and extent of potential complications were recorded. Available subsequent and follow-up examinations were reviewed for the success of therapy.

Results

Of the 14 malpositioned nasogastric tubes, 9 were located in the right (Fig. 1) and 5 were located in the left tracheobronchial tree (Fig. 2). The tips of the 9 tubes on the right were located at the level of the main bronchus ($n = 1$), the intermediate bronchus ($n = 5$), and the lower lobe bronchus ($n = 3$). The tips of the 5 tubes on the left were located at the level of the main bronchus ($n = 1$) and the lower lobe bronchus ($n = 4$). The frequency of malpositioning in the main bronchi ($n = 2$), the intermediate bronchi ($n = 5$), and the lower lobe bronchi ($n = 7$) was 14, 36, and 50 %, respectively.

In 4 patients (28 %), the nasogastric tubes perforated the bronchial tree and the pleura (Figs. 3, 4). One of those patients showed radiographic evidence of parenchymal hemorrhage along the course of the perforating tube (Fig. 3). All four patients suffered subsequent pneumothoraces that had to be drained by chest tubes. Drainage was successful in 3 patients, whereas in 1 patient the chest tube perforated an atelectatic part of the right lower lobe and had to be removed and replaced after CT examination (Fig. 4). Three of the malpositioned nasogastric tubes causing a pneumothorax were placed in the right part and 1 was placed in the left part of the tracheobronchial tree.

In four other patients (28 %), pneumonia developed at the former site of the tip of the malpositioned tube within 4 days. Thus, 40 % of the 10 patients with malpositioned nasogastric tubes, but without evidence of pleural perforation, developed pneumonia at the former site of the tube tip. Pneumonia was diagnosed according to the guidelines defined in the literature [3, 4]. None of these patients had alimentary feeding over the malpositioned nasogastric tube. All pneumonias required antibiotic treatment. In these patients who developed pneumonia, 3 of the nasogastric tubes had been placed in the left part and 1 had been placed in the right part of the tracheobronchial tree.

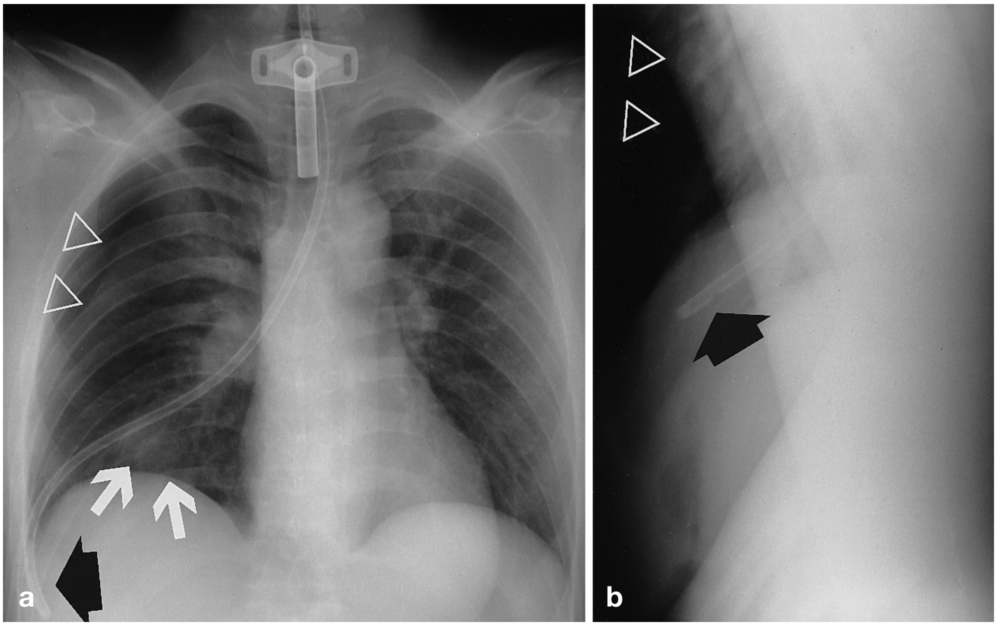

Fig. 3 A, B Supine radiograph of a 27-year-old tetraplegic intensive care patient. The nasogastric tube is shown in the tracheobronchial tree with the tube tip in the region of the right costodiaphragmatic angle (black arrowhead), and there is evidence of a large pneumothorax (open white arrowheads). Along the course of the malpositioned tube, ill-defined densities suggest parenchymal bleeding (white arrows)

In 9 of the 14 patients, the first available radiographs that demonstrated tube malpositioning were postprocedural radiographs, which were obtained immediately after intubation, because, simultaneously with intubation, cannulation of central veins had been performed. In 5 patients, postprocedural radiographs were not taken after nasogastric intubation because the tube was thought to be well positioned. In those 5 patients the radiographs available for analysis were taken 8 to 12 hours after nasogastric intubation.

In all 14 patients, supine or semi-erect frontal chest radiographs accurately demonstrated that the nasogastric tube was malpositioned in the tracheobronchial tree. On both of the two additional cross-table lateral views, the exact location of the malpositioned tube tip could be better visualized than with the frontal view alone. Two of the four CT examinations performed after chest radiography yielded important information. One confirmed the presence of parenchymal infiltrates at the former site of a malpositioned tube tip, and the other demonstrated a leak in the bronchial wall caused by tube perforation (Fig. 4). The presence of this leak was later confirmed by bronchoscopy. The same CT examination gave evidence of intraparenchymal malposition of the chest tube used to drain the pneumothorax that was caused by the perforating nasogastric tube (Fig. 4).

Discussion

Cases of complications of misplacement of small-bore feeding tubes have been reported from at least ten different teaching hospitals in the Western world [5, 6]. All pleuropulmonary complications were the result of inadvertent passage of tubes into the tracheobronchial tree with eventual perforation into the lung and pleural space. Although perforation of the esophagus by a nasogastric tube [7] or an intracranial tube [8] has only been reported sporadically, malpositioning of nasogastric tubes in the tracheobronchial tree appears to be more common [5, 9, 10]. Because the relevant literature [5, 6, 9–13] relies on retrospective collections of cases, the exact frequency of nasogastric tube malpositioning in the tracheobronchial tree is difficult to determine. The literature, however, confirms our own estimates of a malpositioning rate of between 0.5 and 1.5 %.

For the general patient population there are a number of commonly accepted clinical guidelines that suggest proper placement of a nasogastric tube: (1) insufflation of air with sounds heard over the region of the stomach; (2) aspiration of fluid, suggesting placement of the tube in the stomach; (3) passage of the full distance of the tube with easy removal of a guide wire; and (4) absence of coughing, suggesting esophageal passage of the tube [6, 7, 14]. These traditional criteria for proper tube placement, however, have been shown to be suboptimal in critically ill patients [9]. Major underlying factors favoring tube malpositioning include depressed sensorium, impaired gag reflex, recent endotracheal intubation, decreased laryngeal sensitivity, and neuromuscular blocking drugs [5–7, 9, 12–15].

Therefore, traditional criteria for appropriate tube position are not appliable for critically ill patients for the following reasons. Insufflation of air with sounds heard over the region of the stomach should not be ac-

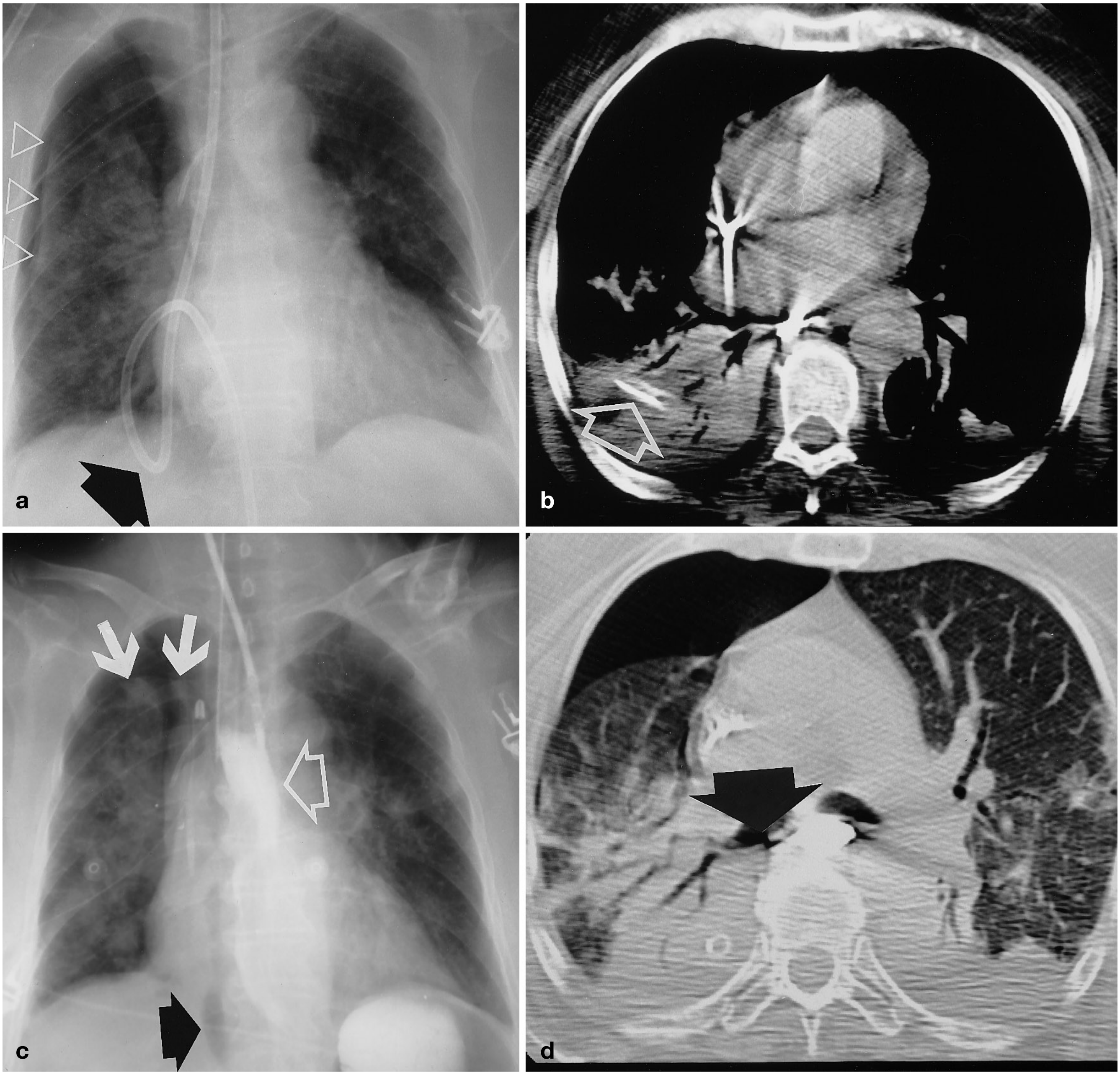

Fig. 4 A–D Supine chest radiographs and CT scans of a 71-year-old intensive care patient. **A** Postprocedural radiograph shows the nasogastric tube in the lung parenchyma and that the tube has entered via the tracheobronchial tree. The tube is curled (black arrowhead). The presence of a pneumothorax on the right side (white open arrowheads) suggests that the tube perforated the pleura. **B** Follow-up supine radiograph after intubation, pleural drainage, and retrieval of the nasogastric tube shows persistent lateral and paramediastinal pneumothorax (white arrows) and also evidence of a paramediastinal collection of air (black arrowhead). Contrast material administered over the retrieved nasogastric tube (white open arrowhead) shows normal passage and thus excludes perforation of the esophagus. **C** Subsequent CT at the level of the left atrium reveals intraparenchymal location of the pleural drain within the atelectatic portion of the right lower lobe (open white arrowhead). **D** Lung window CT at a more cranial level shows the bronchoscopically confirmed leak in the posterior wall of the right main bronchus (white arrowhead)

cepted as evidence of gastric placement because small-bore tubes do not always allow sufficient passage of air and peristalsis may be mistaken for insufflated air. Moreover, air bubbling in the pleura, lung, or esophagus may be transmitted below the diaphragm [9]. Aspiration of fluid should not be interpreted as appropriate placement in the stomach because fluid aspirated may come from the pleural space, from bronchial secretions, or even from the brain [8]. It is believed that if the tube passes the full length and an eventual guide wire is removed easily, the tubing is straight and unlikely to be kinked or coiled up in the lung; however, several reports refute this claim [7, 10, 11, 16]. Additionally, as shown in our patients, the presence of cuffed endotracheal tubes and tracheostomy tubes do not protect the tracheobronchial tree from accidental intubations. Our own experience was confirmed by observations in the literature [5, 9] showing that inflated cuffs may actually predispose the patient to tracheobronchial intubation by altering the normal anatomic characteristics of the esophagus and misdirecting the nasogastric tube.

In view of these potential hazards in intensive care patients, our results emphasize the role of bedside chest radiography in the detection of malpositioned nasogastric tubes and their potential complications. Those results are confirmed by other studies. Miller et al. [9] reported pleuropulmonary complications and sequelae of enteral feeding tubes in seven patients, and four of those patients had no postprocedural radiograph. In two of the three remaining patients postprocedural radiography was performed but the radiograph was not reviewed [9].

The standard literature on intensive care imaging, indeed, provides little information about the radiography of nasogastric tubes and the imaging of eventual complications [17–22]. This and the fact that complications are more common after cannulation of central veins than after nasogastric intubation [17, 18] leads to an underestimation of the hazards of nasogastric tube placement in the tracheobronchial tree. Our results show that this underestimation and the subsequent lack of plain radiographic control may necessitate further costly and invasive techniques like CT or bronchoscopy. Thus, plain bedside radiography appears to be an inexpensive and effective diagnostic modality for the diagnosis of intrabronchial nasogastric tube malpositioning in intensive care patients.

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