Intensive Care Unit Imaging

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KEYWORDS

• ICU • Imaging • Chest radiograph • Pulmonary edema • Atelectasis

KEY POINTS

- Imaging plays a crucial role in caring for the critically ill.
- The radiograph is essential for evaluating the positioning of ICU support and monitoring equipment, and in evaluating for complications of these devices.
- The chest radiograph is useful in diagnosing and evaluating the progression of atelectasis, aspiration, pulmonary edema, pneumonia, and pleural fluid collections.
- CT can be useful when the clinical and radiologic presentations are discrepant, the patient is not responding to therapy, or in further defining a radiographic abnormality.

INTRODUCTION

The chest radiograph is a crucial tool in the care of the critically ill. It serves to diagnose and monitor a variety of cardiopulmonary disorders. Additionally, it is used to evaluate a broad range of thoracic medical devices, ensuring proper positioning and surveying for complications. Daily rounds and prompt communication between radiologist and intensivist can help to improve diagnostic accuracy and manage potential complications.

Indications for Portable Chest Radiography

Posteroanterior and lateral upright radiographs are standard practice for chest radiography. Indications for portable anteroposterior (AP) chest radiography include critically ill patients, trauma patients, those with cardiopulmonary symptoms following surgery, and after line or tube placement, according to the American College of Radiology practice guidelines (revised 2011).[1] There are no absolute guidelines dictating the frequency of chest radiography for intensive care unit (ICU) patients. Several studies assessing the benefit of daily chest radiography in the ICU have been performed, with varied findings.[2–5] Two recent meta-analyses found that eliminating routine daily radiographs in ICU patients did not lead to any negative outcomes compared with a restrictive strategy, which only ordered radiographs based on clinical indications.[6,7] The American College of Radiology recommends chest radiography for patients with clinical changes, and not as a matter of routine.[8] Chest radiographs also should be obtained immediately after the placement of endotracheal tubes, enteric tubes, vascular catheters, and chest tubes.[8] Follow-up is warranted if tube or catheter position is suspected to have changed, or is otherwise clinically indicated.

Technical Factors

Inherent challenges exist in ICU chest radiography, all of which limit diagnostic accuracy. Many patients are debilitated and not readily able to cooperate with the examination, precluding optimal upright posteroanterior positioning. Radiographs are usually obtained in a semi upright or supine AP position. Lateral radiographs are

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usually impractical. Decubitus views may be obtained to evaluate for pleural effusions. External monitoring devices, overlying tubes, and electrocardiographic leads can obscure underlying disease, mimic pathology, and create ambiguity as to the positioning of other support equipment.

MONITORING AND SUPPORT DEVICES

Evaluation of support equipment and monitoring devices is of utmost importance in imaging of patients in the ICU. Early recognition of malpositioning reduces the likelihood of potentially serious complications. Radiologists often review the position of all support equipment as their initial step in appraisal of the radiograph. For this reason, and to underline its importance, evaluation of monitoring and support devices is discussed first.

Endotracheal and Tracheostomy Tubes

Endotracheal tubes are used in patients requiring short-term respiratory support with mechanical ventilation. With the patient's head in a neutral position, the endotracheal tube tip should be located 4 $\pm$ 1 cm above the carina. Neck flexion results in inferior movement of the tube by up to 2 cm, whereas neck extension can cause 2 cm superior migration, hence the colloquial saying "the hose goes with the nose."

A malpositioned endotracheal tube is not an uncommon finding. Intubation of the main bronchi can occur when endotracheal tube position is too low, resulting in subsegmental atelectasis, segmental collapse, or complete collapse of the contralateral lung. The ipsilateral lung may be overventilated, increasing the risk of pneumothorax. Main bronchus intubation is most frequently right-sided, because of a more direct angle of the trachea and right main bronchus (**Fig. 1**). If the endotracheal tube is too high, there may be inadvertent extubation or damage to the larynx. Esophageal intubation is a severe complication compromising ventilation and introducing excessive amounts of air into the gastrointestinal tract, but is typically clinically apparent. Aspiration has been reported to occur in up to 8% of intubations.[9]

The endotracheal balloon cuff should not be inflated beyond the normal diameter of the trachea (**Fig. 2**), and inflation to 1.5 times the normal tracheal diameter frequently causes tracheal damage.[10] Overinflation can rarely lead to acute rupture or can lead to the chronic complication of tracheal stenosis (**Fig. 3**).

Tracheostomy tubes are placed when long-term intubation is necessary. The tracheostomy tube tip should be at approximately the T3 level. Position is maintained with neck flexion and extension. Tracheostomy tube diameter should be approximately two-thirds that of the trachea and as with the endotracheal tube, the cuff should not distend the tracheal wall. Mediastinal air can be seen after uncomplicated tube placement.

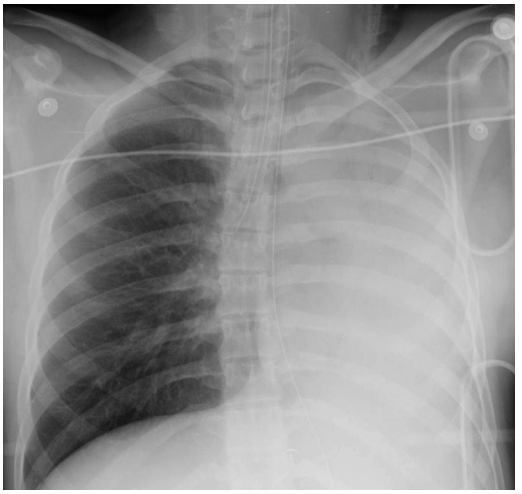

Fig. 1. Right main bronchus intubation. AP chest radiograph in this trauma patient demonstrates the endotracheal tube tip in the right main bronchus. Associated collapse of the left upper and lower lobes is present, with leftward shift of the mediastinum.

Enteric Tubes

Enteric tubes are used for feeding, medication administration, and suction. For feeding, ideal tip position is in the gastric antrum or more distally to reduce aspiration risk. If the enteric tube is

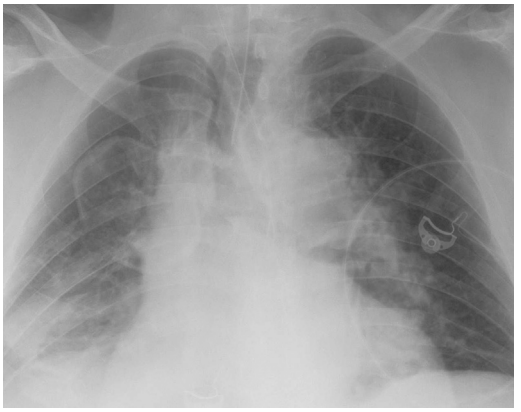

Fig. 2. Overinflated endotracheal tube balloon. AP chest radiograph shows an endotracheal tube cuff that is inflated sufficiently to cause widening of the trachea. The cuff should fill, but not expand, the tracheal lumen.