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Chest X-ray after Tracheostomy Is Not Necessary Unless Clinically Indicated

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Abstract
Background Chest radiography is routinely used post-tracheostomy to evaluate for complications. Often, the chest X-ray findings do not change clinical management. The present study was conducted to evaluate the utility of post-tracheostomy X-rays.
Method This retrospective review of 255 patients was performed at a single-center, university, level I trauma center. All patients underwent tracheostomy and were evaluated for postprocedure complications.
Results Of the 255 patients, 95.7% had no change in postprocedure chest X-ray findings. New significant chest X-ray findings were found in 4.3% of patients, including subcutaneous emphysema, pneumothorax, and new significant consolidation. Only three of these patients required change in clinical management, and all changes were based on clinical presentation alone.
Conclusions Routine chest X-ray following tracheostomy fails to provide additional information beyond clinical examination. Therefore radiographic examination should be performed only after technically difficult procedures or if the patient experiences clinical deterioration. Significant cost savings and minimization of radiation exposure can be achieved when chest radiography after tracheostomy is performed exclusively for clinical indications.

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Introduction

Tracheostomy is a common procedure performed in medicine today. Reported intraprocedural complications include multiple attempts, paratracheal insertion, and posterior tracheal wall laceration. Postprocedural complications can be divided based on timing. Early complications (<7 days) comprise hemorrhage, pneumothorax, subcutaneous emphysema, airway fire, loss of airway, aspiration, and accidental decannulation [1]. Late complications (>7 days) include tracheomalacia, laryngotracheal stenosis, fistula (tracheal-innominate, tracheoesophageal, tracheocutaneous) formation, delayed stoma closure, vocal cord paralysis, and various airway symptoms [1, 2].

Chest radiography is routinely used immediately post-tracheostomy to evaluate for complications, in particular pneumothorax, and to verify tube placement. However, the utility of radiographic confirmation after the procedure remains controversial, one group arguing that it provides safety while others say that it adds an unnecessary cost that provides little additional information. We aimed to examine the argument by reviewing our experience.

Materials and methods

A retrospective study was conducted on tracheostomies performed in a single-center, university setting, level I trauma center over a 5-year period. Patients were identified through an established surgical database: The Trauma Registry of the American College of Surgeons. Charts were reviewed for age, sex, indication for procedure, and hospital day of procedure. Preoperative and postoperative chest radiographs were independently compared and evaluated for significant changes defined as pneumothorax,

pneumomediastinum, subcutaneous emphysema, or a new or significant increase in effusion or consolidation. Each case with a postprocedural chest radiograph was further evaluated for intraoperative and postoperative complications, postprocedure hospital course, treatment of complication, and disposition. This was accomplished by reviewing all pertinent medical records including daily notes and vital sheets. All patients evaluated in this study were monitored in an intensive care unit for at least 24 h following tracheostomy. The overall cost of each portable chest radiograph was estimated at $350 per event.

Results

The final study evaluated 265 patients and ultimately included 255. This comprised 134 open surgical tracheostomies, 121 percutaneous tracheostomies. Ten total patients were excluded due to inadequate data. Patients ranged in age from 12 to 93 years old, and the procedures were performed between hospital day 1 and 46. 84% ($n = 214$) of the tracheostomies were performed for respiratory failure and the remaining 16% ($n = 41$) were performed for airway protection secondary to obstruction, airway trauma, or spinal cord/brain injury.

Of the total study group 95.7% ($n = 244$) had no change in postprocedure chest X-ray when compared to the preoperative chest X-ray. New significant chest X-ray findings were found in 4.3% ($n = 11$) of patients. 1.2% ($n = 3$) showed subcutaneous emphysema and 1.6% ($n = 4$) had a new pneumothorax. The remaining four patients with postprocedure chest X-ray findings had a new significant consolidation with no immediate change in management. In addition, four patients had a change in presentation without any change in chest radiography and were thus managed clinically.

Two of the three patients with subcutaneous emphysema had open procedures, and one had a percutaneous tracheostomy. None had intraoperative complications. Postprocedure, one patient presented clinically and was managed by ventilator modifications. The other two patients had no documentation of clinical changes, and their clinical management was not altered based on radiographic findings.

Of the four patients with new pneumothorax, two had undergone open procedures and two had percutaneous procedures. Two of these patients had no change in clinical presentation and radiographic findings resolved without change in clinical management. One patient, with prior bilateral chest tube placement secondary to blunt trauma, presented post-tracheostomy with respiratory desaturation and subsequent significant pneumothorax on chest X-ray. Tube thoracostomy was performed in response to this clinical change with resolution of hypoxia and radiographic findings. The last patient to present with a pneumothorax had a gunshot wound to the neck requiring a complicated emergent open tracheostomy. This patient was also managed successfully with tube thoracostomy.

Discussion

Tracheostomy is one of the oldest procedures in medicine; dating back to Egypt circa 3600 B.C. Elective tracheostomies were first described by Asclepiades of Bithynia in AD 124 [3]. However, routine tracheostomies performed successfully on a consistent basis did not occur until Chevalier Jackson, a laryngologist, provided a detailed description of the procedure in 1909. He emphasized a long incision, good exposure, division of the thyroid isthmus, and in a later publication, avoidance of incision of the first and second tracheal rings [3, 4]. The most significant modification to this procedure occurred in the 1980s when Ciaglia and colleagues popularized the percutaneous approach. This emphasized smaller incisions and a tracheocutaneous tract that was developed by sequential dilatation prior to placement of the synthetic stoma [5].

Rising health care costs have driven physicians to re-evaluate clinical management of illness and disease. As the population of people over the age of 65 grows, the delivery of critical care has come under scrutiny as a major contributor to health care costs. With this in mind, particular attention to intensive care unit protocol should be evaluated in terms of both clinical and financial utility [6]. Tracheostomy in particular has been performed by physicians for many centuries. Over the course of this time, there have been few changes to the techniques performed. As such, the complications resulting from tracheostomy have remained relatively the same. Immediate postprocedure chest radiography has been routinely employed to evaluate for these complications, particularly pneumothorax. Although this practice was once considered necessary, the utility of routine chest roentgenogram has recently come under debate [7].

Overall complication rates following percutaneous tracheostomies have been described from 3 to 18% [8, 9]. Open procedures have comparable intraprocedural and early postprocedural complications rates with a slightly increased risk of wound infection in the late postprocedural period [1, 10]. Pneumothorax and pneumomediastinum are the most common urgent intraprocedural complications that may require immediate attention. Evaluating for these complications is the main reason postprocedural chest X-rays are ordered routinely. Pneumothorax incidence after tracheostomy ranges from 0 to 17% [8, 11, 12]. Three proposed mechanisms of pneumothorax are direct injury to

pleura, air dissection through a deep layer of middle cervical fascia leading to pneumomediastinum and/or pneumothorax, and rupture of an alveolar bleb [13]. Recognizing pneumothorax is important, but may not be necessary unless clinically relevant. For this reason several studies have refuted the use of post-tracheostomy radiography [6, 8, 9, 11, 12, 14].

Tarnoff et al., retrospectively analyzed 268 patients undergoing elective tracheostomy. Eight (2.4%) of the patients in this study had postoperative subsegmental atelectasis and one (0.3%) had a postoperative 10% pneumothorax. There were no significant management changes based on the radiographic findings. This study concluded that abnormalities revealed by routine chest radiography after tracheostomy did not alter patient management enough to warrant the cost [6]. Swanson et al., retrospectively evaluated 119 patients who underwent percutaneous dilatational tracheostomy with similar results, and concluded that chest radiography is indicated when clinical findings suggest pneumothorax or pneumomediastinum [14]. The only generally accepted use of routine post-tracheostomy X-rays is in the pediatric population where the incidence of pneumothorax is significantly higher (10–19%) due to high-riding pleural domes [11, 15].

In our study, the rate of pneumothorax (1.6%) was comparable to the data reported [9]. The other significant complication encountered was subcutaneous emphysema (1.2%). This was thought to be significant since it could suggest an underlying process such as pneumothorax or tracheal injury. Only one patient with subcutaneous emphysema had clinical changes that were corrected by modifying the ventilator settings. Of note, this change in management was based on clinical symptoms and not on X-ray findings. The other two patients with subcutaneous emphysema had no documentation of clinical changes or change in clinical management. Four total patients had a pneumothorax identified on chest roentgenogram. Two were uncomplicated and without clinical symptoms or change in clinical management. One patient had a significant pneumothorax after elective percutaneous tracheostomy on hospital day 19 for respiratory failure. Prior to tracheostomy the patient already had bilateral chest tubes for pneumothorax initially placed secondary to blunt trauma. A second chest tube was inserted for acute desaturation after tracheostomy and subsequently worsening pneumothorax on X-ray. The fourth patient to present with pneumothorax had an emergent open tracheostomy for airway protection after multiple gunshot wounds to the neck and face. This patient likewise already had bilateral chest tubes placed in the emergency room for presumed pneumothorax. This tracheostomy was noted to be complicated. Difficulty ventilating the patient after the procedure required changes in ventilator settings and manipulation of the tracheostomy tube.

The common theme among all patients in the present study is that changes in clinical management were based on clinical presentation and not radiographic findings. Radiography merely confirmed a pathophysiological change. With regard to the two patients with pneumothorax requiring changes in clinical management, both were trauma patients with known prior pneumothorax. This suggests that patients with known prior pneumothorax are at risk for recurrence after tracheostomy, even with existing thoracostomy tube placement. More importantly, this reconfirms that pneumothorax requiring intervention will initially present clinically and that clinical changes should be the stimulus for radiography and intervention.

Overall, 95.7% of patients had no change in postprocedure chest X-ray when compared to the preoperative chest X-ray. Likewise, there were no changes in clinical presentation after the procedures. Thus, postprocedural chest roentgenograms were irrelevant. To further support this, Gray et al., have demonstrated that routine postprocedural (central venous catheter, pulmonary artery catheter, intubation) chest radiographs revealed clinically significant complications only when clinically anticipated [16]. Further studies demonstrate that life-threatening complications are usually detected clinically prior to chest radiography being performed or evaluated [6].

The cost of a portable chest X-ray at our institution is approximately $350 per occurrence. This does not include the expense of nursing care, radiology review, or man-hours spent tracking radiographic procedures performed. Each examination, therefore, is far more costly than the expense of a radiograph alone. This not-withstanding, the procedure-related savings could have been at the very least $86,800 (248 × $350) had chest X-rays been performed for clinical indications suggesting pneumothorax or subcutaneous emphysema rather than for compliance to routine protocol. Furthermore, unnecessary exposure of patients to radiation has recently been a point of considerable controversy [17]. By establishing a protocol where clinical change indicates a need for chest radiography, not only will exposure to radiation be minimized, but patient safety can also be improved. In particular, patients with fresh tracheostomy will not be repositioned as required for each radiographic study.

Chest X-ray following tracheostomy is also used to evaluate for effusion, other pulmonary complications that may result from this procedure, and tube position. In the present study, four patients had a new significant consolidation after the procedure, but there was no immediate change in management of these patients based on the consolidation. Most patients had consolidation on chest X-ray prior to tracheostomy; therefore it is difficult to fully determine if the new finding was a result of tracheostomy alone. Therefore, tracheostomy does not appear to be a risk factor for new consolidation or opacity on chest X-ray.

With regard to tube position, there is evidence that supports the use of chest X-ray to evaluate the position of endotracheal tubes; however, the data are lacking for tracheostomy tube placement [18]. Clinical exam—i.e., bilateral auscultation—should confirm tracheal placement after tracheostomy, obviating the need for routine chest X-ray.

Compared to the articles reviewed, this analysis is one of the largest evaluating the need for chest X-rays following tracheostomy. And unlike the others, the data group also includes both emergent and elective procedures performed both percutaneously and open. Despite the given results the question then remains why the practice of post-tracheostomy chest X-rays is routinely performed in some institutions? Perhaps this is because the data are largely limited to small studies and retrospective analysis. Furthermore, anecdotal experience and adherence to classical criteria for examination may lead practitioners to the continued use of post-tracheostomy X-ray.

Our retrospective examination demonstrates that routine chest X-ray following tracheostomy fails to provide additional information above clinical examination. As such, radiographic examination should be performed only after technically difficult procedures or if the patient experiences clinical deterioration (i.e., respiratory distress including desaturation, hypoxia, hypercapnia, dyspnea, and persistent tachypnea) unresponsive to ventilator modification. Significant cost savings and minimization of patient exposure to radiation can be achieved when chest radiography after tracheostomy is performed exclusively for clinical indications. Prior to this study, our institution was performing routine chest X-ray following tracheostomy. However, with these results our practice has shifted to performing chest X-rays only when clinically indicated. In the continuum of this study, our institution is also preparing a prospective trial further evaluating these conclusions.

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