Original Article

Routine chest X-rays after the removal of chest tubes are not necessary following esophagectomy

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Background: Chest X-rays (CXRs) are commonly performed after removing chest tubes following surgery. However, the value of this practice is unclear for patients who underwent esophagectomy. Therefore, the aim of this study was to investigate the clinical relevance of routinely performing a CXR after chest tube removal during the postoperative course of esophagectomy.

Methods: A single-center prospective database was used to select all patients who underwent esophagectomy with gastric conduit reconstruction between 2015 and 2017. Patients who received a CXR within 4 hours after removal of at least one chest tube were included. The radiological reports of these CXRs were evaluated for intrapleural air and fluid. Cases requiring re-insertion of a chest tube on the day of CXR or the day afterwards were identified and the clinical situation of these patients was reviewed.

Results: Some 117 patients were included and a total of 231 chest tube removals were followed by a CXR within 4 hours. Re-insertion of a chest tube was performed in a total of 6 cases (3%) on the day or the day after this CXR. All these 6 patients had clinical signs or symptoms indicating respiratory problems. In total, new intrapleural air was found on the ipsilateral side of previous chest tube removal in 33 cases (14%) and new intrapleural fluid occurred on the ipsilateral side of previous chest tube removal in 24 cases (10%).

Conclusions: In conclusion, a CXR after chest tube removal may safely be reserved for patients who develop clinical signs or symptoms that indicate respiratory problems.

Keywords: Postoperative imaging; X-ray; chest tube; ERAS

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Introduction

Esophageal cancer is the ninth most common cancer worldwide and remains an important cause of cancer death (1). Curative treatment is only possible for selected patients and consists of neoadjuvant therapy followed by esophagectomy (2). Since meticulous mediastinal lymphadenectomy is considered necessary to achieve an optimal oncological outcome, a transthoracic approach is preferred for esophagectomy by most surgeons (3-5).

To prevent potential postoperative pulmonary compression by accumulation of intrapleural air or fluid, placement of at least one chest tube is advised during esophagectomy (6). Chest tubes can generally be removed when producing less than 200 mL fluid per day and in case no air leak is observed (6). To diagnose potential hazardous situations, such as massive pneumothorax or re-accumulation of intrapleural fluid, it is common practice to perform a routine chest X-ray (CXR) several hours after removing a chest tube (7). However, studies that included patients who underwent a variety of cardiothoracic procedures (i.e., coronary artery bypass grafting, valve replacements, and other cardiothoracic procedures)

indicated that radiological abnormalities upon routine CXRs after chest tube removal often do not require re-intervention and that clinical signs of respiratory problems might be appropriate criteria to guide further diagnostic imaging (8,9). In this light, the practice of routinely performing a CXR after chest tube removal has also become subject of debate for the postoperative care pathway of patients undergoing esophagectomy.

To date, no studies have evaluated the value of routinely performing a CXR after removing chest tubes during the postoperative course of esophagectomy. Therefore, the aim of this study was to investigate the clinical relevance of a routine CXR after chest tube removal in the postoperative management of esophagectomy.

Methods

Patients

A prospectively maintained database was used to select all patients who underwent esophagectomy with gastric conduit reconstruction in the University Medical Center Utrecht between 2015 and 2017. Patients who received a CXR within 4 hours after the removal of at least one chest tube according to available radiological reports were included. No specific exclusion criteria were defined. The current study was approved by the institutional review board and the need for written informed consent was waived.

Surgical procedure

Patients principally received a robot-assisted minimally invasive transthoracic esophagectomy with 2-field lymphadenectomy and gastric conduit reconstruction. A laparoscopic transhiatal approach was used for selected patients who were considered unfit for a transthoracic procedure, as discussed and agreed during multidisciplinary tumor board meetings. A hand-sewn esophagogastric anastomosis was created in all patients.

Management of chest tubes and drains

Both water seal and Jackson-Pratt (JP) chest tube were commonly placed during esophagectomy. The standard protocol included the placement of two or three chest tubes at the time of esophagectomy. At least one water seal chest tube was kept in place until postoperative day (POD) 1. From POD 1 onwards, removal of chest tubes was performed when the drained fluid volume was less than 200 cc/24 h, non-contaminated, and did not show signs of air leak. Chest tubes were pulled out at full expiration and a CXR was routinely performed 4 hours later to evaluate for accumulation of intrapleural air or fluid. All CXRs were assessed by radiologists who documented their findings in the electronical patient file. The necessity for re-intervention in terms of chest tube re-insertion was assessed by the attending surgeon based on the combination of radiological and clinical findings.

Data collection & outcome measures

Baseline characteristics were collected from a prospective database and consisted of age, gender, American Society of Anesthesiologists (ASA) score, tumor histology, clinical tumor stage, neoadjuvant therapy, and surgical approach. The dates of removing intraoperatively placed chest tubes were also prospectively recorded. The primary outcome measures included the proportion of patients with radiological signs of intrapleural air or fluid and the rate of chest tube re-insertion on the day of routine CXR or on the day afterwards. Radiological reports were retrieved from the electronic patient files and retrospectively evaluated for any quantity of intrapleural air or fluid on either side of the thorax. Clinical symptoms, respiratory rate, need for oxygen support, and oxygen saturation level at the time of routine CXR and at the time of deciding to re-insert a chest tube were also retrospectively collected from the electronic patient file. Patients who required chest tube re-insertion on the side of previous chest removal were identified by reviewing clinical documentation of the day and the day after chest tube removal in all patients.

Statistics

All analyses were performed using SPSS version 21 (SPSS Inc.). Continuous variables were expressed as a mean (standard deviation) or median (range or interquartile range), depending on data distribution. Categorical variables were presented as a number with the corresponding percentage. No statistical comparisons between groups were made.

Results

Patient characteristics

The baseline characteristics of the 117 patients who

Table 1 Baseline characteristics of 117 patients who received a routine chest X-ray after the removal of at least one chest tube that was placed during esophagectomy for cancer

Characters	Value
Age, years (mean ± SD)	63.3±8.5
Gender, n [%]	
Male	82 [70]
Female	35 [30]
ASA score, n [%]	
I	19 [16]
II	71 [61]
III	27 [23]
Tumor histology, n [%]	
Adenocarcinoma	76 [65]
Squamous cell carcinoma	37 [32]
Benign disease	2 [2]
Other	2 [2]
Clinical T stage, n [%]	
Tx	1 [1]
T1	7 [6]
T2	19 [16]
T3	83 [71]
T4	5 [4]
Benign	2 [2]
Clinical N stage, n [%]	
N0	39 [33]
N1	54 [46]
N2	16 [14]
N3	6 [5]
Benign	2 [2]
Neoadjuvant therapy, n [%]	
Chemoradiotherapy	102 [87]
Chemotherapy	4 [3]
Radiotherapy	1 [1]
None	10 [9]
Surgical approach, n [%]	
Minimally invasive McKeown	56 [48]
Minimally invasive Ivor-Lewis	35 [30]
Open McKeown	17 [15]
Laparoscopic transhiatal	9 [8]

were included are demonstrated in *Table 1*. The majority of the patients was male (n=82, 70%) and the mean age was 64 years. Most patients presented with a tumor at clinical stage T3 or higher (n=88, 75%) and had at least one tumor-positive lymph node according to clinical staging (n=76, 65%). Neoadjuvant chemoradiotherapy was usually provided (n=102, 87%) and was followed by esophagectomy through a minimally invasive transthoracic (n=91, 78%), minimally invasive transhiatal (n=9, 8%), or open transthoracic (n=17, 15%) approach. The median day of removing the first chest tube was POD 3 (interquartile range, 1–4) and the median day of removing the last chest tube was POD 8 (range, 6–11).

Routine CXR findings

A CXR was performed after the removal of 231 intraoperatively placed chest tubes. Intrapleural air was seen on 78 CXRs (34%) and was a new finding on the ipsilateral side of previous chest tube removal in 33 cases (14%). Intrapleural fluid was mentioned in the radiological reports of 87 CXRs (38%), which involved a new finding that was ipsilateral to previous chest tube removal in 24 cases (10%).

Chest tube re-insertions

Out of the 231 chest tube removals that were followed by CXR, a chest tube was re-inserted in 6 cases (3%) and these re-interventions were performed 2 to 34 hours after the CXR. *Table 2* demonstrates the clinical situation of these patients at the time of CXR, which had shown intrapleural air (n=3, 1%), intrapleural fluid (n=2, 1%), or none of these abnormalities (n=1, 1%). At the time of deciding to re-insert a chest tube, 3 of these patients had an increased respiratory rate (20, 28, and 30 breaths per minute), 1 patient had a decreased respiratory rate (10 breaths per minute), and in the remaining 2 patients no respiratory rate was documented. Oxygen support was required in all 6 of these patients (range, 3–40 L/min) to achieve acceptable saturation levels (range, 92–97%). All 6 patients who underwent chest tube re-insertion reported dyspnea at the time of CXR, at the time of deciding to re-insert a chest tube, or both.

Table 3 shows the other clinical signs and the ultimate diagnosis of the 6 patients who underwent chest tube re-insertion (patients A-F). Patients A and B were diagnosed with a pneumothorax in absence of other underlying pathology. Both had anamnestic dyspnea and a decreased

Table 2 Clinical situation at the time of routine CXR for the 6 patients who underwent re-insertion of a chest tube

Patient	Type of tube	Side	POD	Routine CXR findings†	Anamnestic dyspnea	Respiratory rate (min^{-1})	sO_2 (%)	O_2 support (L/min)
A	Water seal	Left	4	Air	No	–	95	4
B	Water seal	Right	1	Air	No	19	95	4
C	JP drain	Right	6	Air	No	32	92	3
D	Water seal	Left	2	Fluid	Yes	24	93	40
E	Water seal	Right	4	Fluid	Yes	–	95	4
F	Water seal	Left	13	None	Yes	19	88	5

†, on the side of previous chest tube removal. POD, postoperative day (of removal); JP drain, Jackson Pratt drain.

Table 3 Clinical situation at the time of deciding to re-intervene for the 6 patients who underwent re-insertion of a chest tube

Patient	Time between CXR and chest tube re-insertion (hours)	Anamnestic dyspnea	Respiratory rate (min^{-1})	Arterial sO_2 (%)	O_2 support (L/min)	Other clinical signs	Diagnosis
A	7	Yes	–	95	4	None	Pneumothorax
B	33	Yes	10	95	15	Thoracic pain	Pneumothorax
C	2	Yes	30	94	3	Thoracic pain	Anastomotic leakage
D	2	Yes	28	97	40	None	Atelectasis with pleural effusion
E	5	Yes	–	95	4	Fever	Pneumonia with empyema
F	34	No	20	92	5	Fever and subcutaneous emphysema	Anastomotic leakage and pneumonia

CXR, chest X-ray.

respiratory rate was observed in patient B (10 breaths per minute), which may have been in response to thoracic pain that was present. The last CXR before chest tube removal had shown a small apical pneumothorax in both patients A and B. In patient C, who also received a new chest tube after showing intrapleural air upon the CXR after chest tube removal, anastomotic leakage was diagnosed by endoscopy on the same day. No signs of pneumothorax had been present on the last CXR prior to chest tube removal. In patients D and E, intrapleural fluid was observed on the CXR, which originated from atelectasis with pleural effusion (patient D) and pneumonia with empyema (patient E). The last CXR prior to chest tube removal had shown bilateral intrapleural fluid in both patients, which was most evident on the ipsilateral side of chest tube re-insertion. In patient F, no signs of intrapleural air or fluid were found upon CXR, but this patient developed fever and had subcutaneous emphysema due to a combination of anastomotic leakage and pneumonia (patient F). Although intrapleural air was not present on earlier CXR in the patient, subcutaneous emphysema was already present before removal of the chest tube.

Discussion

In this study, a CXR was routinely performed after chest tube removal, aiming to exclude clinically relevant intrapleural air or fluid as part of the standard postoperative protocol for esophagectomy. The chest tube re-insertion rate after the removal of chest tubes was 3%. The CXRs prior to this chest tube re-insertion showed intrapleural air in 1%, intrapleural fluid in another 1%, and none of these abnormalities in the remaining 1%. All patients who underwent chest tube re-insertion presented with clinical signs or symptoms.

The current findings suggest that intrapleural air and

fluid are relatively common radiological findings after removing chest tubes following esophagectomy. Although the incidence of clinically insignificant pneumothorax is likely minimized by removing a chest tube at full expiration, a small proportion of patients is still expected to develop a clinically relevant pneumothorax after chest tube removal (10). In a study comparing chest tube removal at full expiration versus at full inspiration after pulmonary resection, a non-significant difference in clinically relevant pneumothoraces was found with an incidence of 1% in the former and 3% in the latter group (10). These rates appear to be in line with the current results and with another study that demonstrated that a CXR following chest tube removal rarely changes patient management (11,12).

In the current study, clinical signs or symptoms were present in all patients who underwent re-insertion of a chest tube. A pneumothorax without other pathology was ultimately diagnosed in one-third of these patients. The other two-thirds of these patients had clinical symptoms including fever, thoracic pain, and subcutaneous emphysema, which originated from another postoperative complication (i.e., anastomotic leakage, atelectasis, and pneumonia). All developed respiratory signs or symptoms that would have been reason to perform diagnostic tests, of which a CXR is often one of the first, mostly followed by computed tomography (CT) scanning. However, as 5 out of 6 patients who required re-insertion of a chest tube already showed signs of small amounts of intrapleural air or fluid on an earlier CXR, it should be emphasized that thorough evaluation of previous imaging is essential before removing any tubes. The decision to remove a drain under such clinical circumstances might be challenged, but it must be noted that non-productive chest tubes should principally be removed since they might otherwise only pose a risk of complications such as insertion site infection. To decide which patients need a CXR after chest tube removal, clinical appearance may be a suitable indicator. In a study that included patients who underwent various cardiothoracic surgical procedures (e.g., valve replacement, coronary artery bypass grafting), the cardiac surgeon scored the likelihood of finding a pneumothorax upon CXRs following chest tube removal, based on clinical characteristics. These characteristics included respiratory or hemodynamic changes (i.e., decreased oxygen saturation, dyspnea, tachypnea, decreased cardiac output, or significant drop in blood pressure) and problems that were experienced during chest tube removal (13). Although some small pneumothoraces occurred in patients who were classified as having the lowest level of suspicion, none of these patients required re-insertion of a chest tube (13).

Rational patient selection for postoperative imaging is in line with the increasing demands to effectively organize care and to optimally allocate expenses. The combination of available literature and current results suggests that a routine CXR after chest tube removal does not have to be part of the standard postoperative treatment pathway for esophagectomy, but may only be performed in patients who present with clinical signs or symptoms of respiratory problems. It should be noted, however, that the current study did not aim to identify clinical criteria that can be used to determine which patients need a CXR. Therefore, it seems advisable to clinically monitor patients after chest tube removal and to perform a CXR in case of any signs or symptoms that may be attributable to respiratory problems. Future research may strive to establish and validate a clinical scoring system to assess the need for a CXR in this context.

This study derives its strength from a largely prospective nature of data collection which resulted in reliable data. Furthermore, the aim of this paper was to provide insight in clinical decision making after removal of chest tubes, which was achieved by strictly assessing the value of the routine CXR. One might argue that using various types of tubes (i.e., water seal and JP tubes) might have interfered with the homogeneity of the cohort. However, this is not believed to be a hampering factor regarding the representability of results. Another limitation of the current study may be the retrospective nature of part of the data collection, which resulted in some missing parameters for a small group of patients.

In conclusion, this study suggests that the practice of routinely performing a CXR after chest tube removal following esophagectomy may safely be abandoned. Performing a CXR remains advisable in case of any signs or symptoms of respiratory problems after chest tube removal.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethical Statement: The current study was approved by the institutional review board and the need for written informed

consent was waived.

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