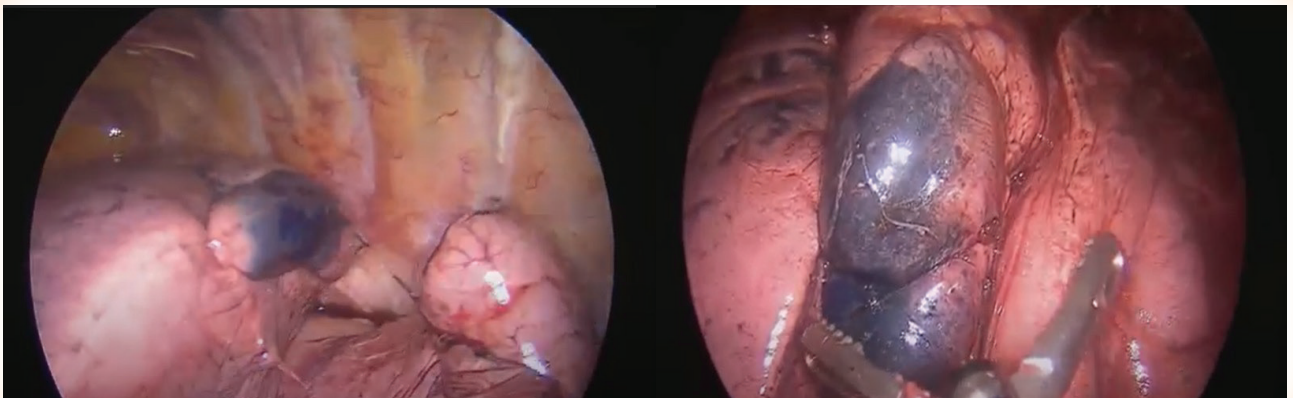


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Table of Contents

Volume 8

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Original Articles

- 68 Feasibility of uniportal VATS in the histopathological diagnosis of the peripheral pulmonary nodules which are marked by methylene blue before resection**
Volkan Karaçam, Fatma Mutlu, İlkay Kaya, Aytaç Gülcü, Kemal Can Tertemiz, Aydın Şanlı, Duygu Gürel
- 74 Importance of simulation devices in thoracic surgery education: a prospective comparative study**
Celal Bugra Sezen, Gamze Tanrikulu, Mustafa Vedat Dogru, Semih Erduhan, Yasar Sonmezoglu, Volkan Erdogu, Nisa Yildiz, Ozkan Saydam, Muzaffer Metin
- 80 Is it a coincidence that COVID-19 and pneumothorax coexist?**
Serkan Bayram, Mustafa Akyıl, Pelin Erdizci, Serda Kanbur Metin, Abidin Levent Alpay, Selami Volkan Baysungur
- 85 Analysis of non-operative management of 53 thoracic gunshot injuries in a training hospital from a thoracic surgical perspective**
Merve Sengul Inan, Hakan Isik, Ufuk Unsal, Ersin Sapmaz, Kuthan Kavakli, Hasan Caylak, Alper Gozubuyuk
- 91 Single center experience of war-related thoracic injuries in Syria**
Ahmet Ulsan, Ibrahim Emre Tunca, Maruf Sanli, Ahmet Feridun Isik
- 96 Analysis of erroneous appointments from the thoracic surgery outpatient clinic of a training hospital**
Ekin Zorlu, Önder Kavurmacı
- 100 Abdominothoracic fistulas due to complicated Echinococcosis: surgical treatment and outcome**
Yekta Altemur Karamustafaoglu, Fazlı Yanık, Yener Yoruk

Case Report

- 106 Esophageal perforation, aortic pseudoaneurysm and aorto-oesophageal fistula caused by ingestion of a chicken bone**
Cihan Ozgur, Yekta Altemur Karamustafaoglu, Nermin Tuncbilek
- 109 Six different types of primary tumors in a lady: multiple primary tumors**
Funda İncekara, İlteriş Türk, Funda Demirağ, Şevki Mustafa Demiröz, Göktürk Fındık
- 113 A case of tracheal adenoid cystic carcinoma treated with carinal resection and adjuvant radiotherapy**
Murat Erdogan, Omer Topaloglu, Sami Karapolat, Ali Akdogan, Celal Tekinbas

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Original Article

Feasibility of uniportal VATS in the histopathological diagnosis of the peripheral pulmonary nodules which are marked by methylene blue before resection

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ABSTRACT

Background: This study aims to reveal the diagnostic success to determine nodule localization, by marking the nodules with methylene blue, its contribution to operation time, and perioperative complications.

Materials and Methods: In 52 patients with peripheral pulmonary nodules smaller than 20 mm, the nodule was marked by injecting 0.5-1 cc methylene blue with the guidance of computed tomography (CT) with a Chiba needle (22 G), before they were taken to the operating room. A frozen section examination was done after wedge resection with VATS.

Results: The mean nodule size in the study was 8.85 mm (3-25 mm). The mean measurement distance to the chest wall at the peripheral endpoint of the nodules was 9.0 mm (1-40 mm). Of the nodules, 22 were solid, 15 were semisolid, and 15 were ground glass. Pathology subtypes were as follows, especially in ground glass lesions whose localization could not be determined without marking; 7 adenocarcinomas, 2 adenocarcinomas in situ, 4 atypical adenomatous hyperplasias, and 2 benign cytology. The pathologies for the other 37 patients resulted in 13 benign cytology, 10 metastases of known malignancy, 3 lung squamous cell carcinoma (pT1bN0, pT1aN1), 7 adenocarcinoma (pT1aN0- pT2N0), 1 adenocarcinoma in situ, 2 typical carcinoids (pT1aN0) and 1 atypical adenomatous hyperplasia.

Conclusions: Through CT-guided percutaneous methylene blue marking, the localization of peripherally located, small-sized, and non-palpable lesions can be detected easily with uVATS. In this way, unnecessary thoracotomy can be avoided, the operation can be performed quickly and with low morbidity, and the diagnosis of lung cancer can be provided at an early stage.

Keywords: videothoroscopic surgery, methylene blue, dye, ground glass nodule, uniportal

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Introduction

Pulmonary nodules are lesions that are 3 cm or less in diameter radiologically and at least partially located in the lung parenchyma, with solid or sub-solid features [1]. With the widespread use of low-dose computed tomography (CT) and the widespread use of lung cancer screening programs all over the world and in our country, there is an increasing number of pulmonary nodules have been detected [2]. Pulmonary nodules can be observed due to malignant or benign neoplasms of the lung, infectious, vascular, traumatic, or congenital pathologies [1]. Histopathological diagnosis is required to elucidate lesions suspicious of malignancy. The indications for the histopathological diagnosis of pulmonary nodules change according to the following; radiological densities of the nodule (spiculation, solid-ground glass), smoking history over 30 p/y, size over 6 mm, growth rates, family history, emphysema, and fibrosis [3].

Anatomical resection has already been performed by thoracotomy for lesions that were invisible and palpable nodules. Video-assisted thoracoscopic surgery (VATS) provides higher efficacy and less morbidity, compared to traditional thoracotomy in the diagnosis and treatment of nodules. Resection with VATS has become a popular therapeutic modality for potentially malignant nodules [4]. Preoperative marking is important for accurate resection, especially in invisible, non-palpable, or deeply located nodules. In this way, the operation time is shortened, and morbidity and transition rates to thoracotomy are reduced [5]. Various marking methods are mentioned in the literature. These are using autologous blood, hook wire, micro coil, determination of the lesion with intraoperative ultrasound, methylene blue, etc. Each technique has advantages and disadvantages [6].

In this study, we retrospectively evaluated the peripheral pulmonary nodules which we resected by performing a uniportal VATS (uVATS) after being marked by methylene blue. This study aims to reveal the diagnostic success of this procedure, and its contribution to determining nodule localization, operation time, and perioperative complications in cases with nodules marked with methylene blue.

Materials and Methods

Between January 2017 and December 2020, 52 patients who underwent uVATS wedge resection with methylene blue marking due to peripheral pulmonary nodules were evaluated retrospectively. Cases with a nodule that has a peripheral location less than 3 cm to the visceral pleura, smaller than 3 cm in size, and have a density that could

not be seen or palpated videothoracoscopically were included in the study. Cases with nodule localization close to the hilar region and large vascular structures, who have a previous history of thoracotomy, severe emphysema or severe chronic obstructive pulmonary disease, and bleeding diathesis disorders were not included in the study. This study was approved by the Dokuz Eylul University Ethics Committee (29.06.2022, 2022/22-42).

All patients were marked with methylene blue under the guidance of CT in the interventional radiology unit before the surgical procedure. The closest distance of the nodule to the thoracic wall was determined using the steepest angle possible. Marking was done on the skin with a marker pen. After appropriate sterilization measures and subcutaneous local anesthesia, the nodule was reached by a 22-gauge Chiba needle. To see that the needle was oriented correctly, control images were taken to include the sections where the nodule was located. When the needle tip reached the nodule, methylene blue was started to be given. The needle was slowly withdrawn by injecting methylene blue (0.5-1 cc) along the line up to the visceral pleura (Figures 1,2). After the marking, the patients were transported to the operating room after the final follow-up CT was seen in terms of complications and procedural success. Nasal oxygen (2-3 L/min) was given to all patients in terms of pneumothorax throughout the transport and until the start of the operation.

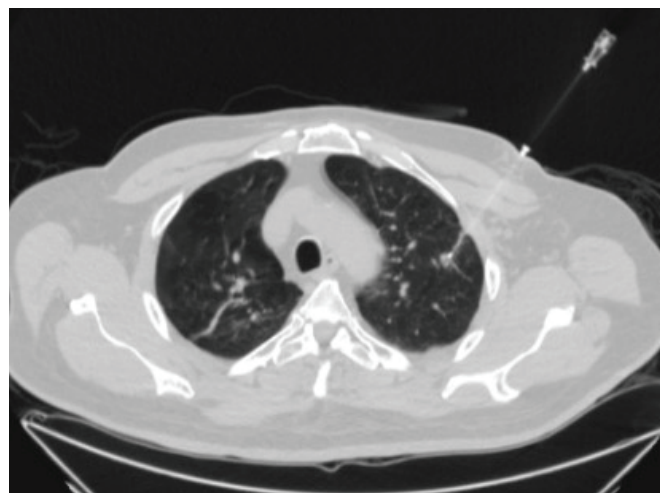


Figure 1. Methylene blue marking of the left upper lobe lesion under CT guidance.

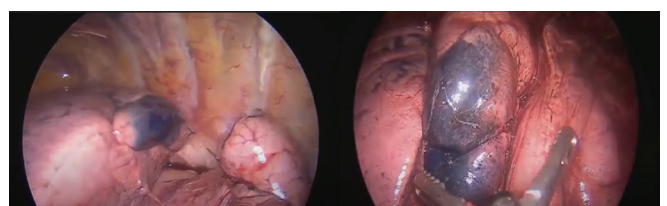


Figure 2. The parenchymal coloration during the VATS procedure.

All cases were intubated with a double-lumen endotracheal tube. Wedge resection was performed by uVATS with a 3-4 cm incision from the 4-5th intercostal space in the lateral decubitus position under general anesthesia (Figure 3). The frozen section was studied in all cases. UVATS lobectomy and mediastinal lymph node dissection were performed in the same session in cases without distant organ metastasis and mediastinal lymph node involvement, and frozen resulted in primary lung malignancy. Limited resection with wedge resection was performed in cases with benign, uncertain, or metastasis of primary malignancy as a result of frozen. After the operation, a 24-28 F thoracic drain was applied into the thorax, and the operation was terminated.

The cases included in the study were evaluated according to age, gender, size of the nodule, the density of the nodule on imaging (solid, semisolid, ground glass), histopathological diagnosis, distance to the chest wall, surgery performed (lobectomy with mediastinal lymph node dissection or wedge resection), complications, duration of operation, duration of follow up with a drain, time of hospitalization and one-year survival retrospectively.

Statistical Analysis

Statistical analyzes were performed using SPSS 19.0 software (SPSS Inc., Chicago, IL, USA). Continuous variables were expressed as mean $\pm$ std. Categorical variables were expressed as deviation, frequency, and percentage. The student's t-test and Mann-Whitney-U test were used depending on the situation of the variables i.e. normally distributed or not.

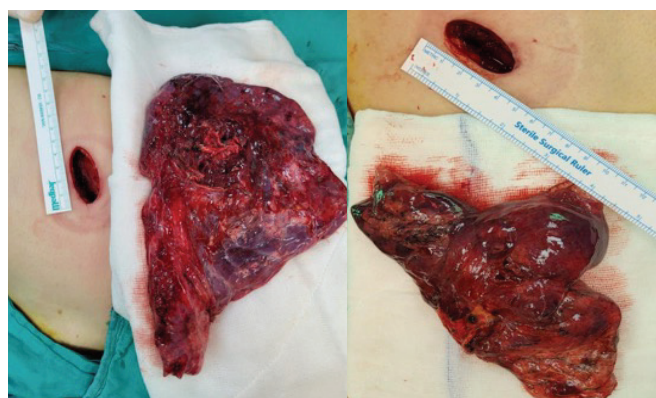


Figure 3. Four cm incisions for uVATS and lobectomy specimens.

Results

Thirty of the cases were male and 22 were female. The mean age was 58.9 ± 10.8 years (25-77 years). The mean size of the nodules measured by computed tomography (CT) was 8.9 ± 3.3 mm (4-20 mm), and the mean pathological size was 8.56 ± 4.3 mm (3-25 mm). The mean distance of the nodule to the visceral pleura was 9 ± 5.9 mm (4-29 mm). Of the nodules, 22 (42.3%) were solid, 15 (28.8%) were semisolid, and 15 (28.8%) were ground glass. The marking process was performed in 17 ± 3.1 minutes on average (13-24 minutes).

Pneumothorax developed in 13 (25%) cases after marking; however, none of them required tube thoracostomy. Perilesional hemorrhage was reported in two (3%) cases and the pain was reported in 23 (44.2%) cases. According to the frozen result, 30 (57.6%) of the nodules were malignant, 15 (28.8%) were benign, and 7 (13.4%) were indeterminate. The mean time from the beginning of the surgery to the end of the wedge resection was 20 ± 6.8 (13-25) minutes. The results according to the final histopathological diagnosis are shown in table 1.

UVATS lobectomy and mediastinal lymph node dissection were performed in the same session in 7 (13.4%) cases that were diagnosed as primary lung malignancy according to the frozen result and were suitable for surgery. Complementary resection and mediastinal lymph node dissection with uVATS were performed in 6 (11.3%) cases whose frozen pathology results were uncertain but the final pathology result was evaluated as primary lung cancer (Table 2).

Table 1. Histopathological diagnoses according to the final pathology result.

Histopathology	N	(%)
Adenocarcinoma	15	28.8
Atypical adenomatous hyperplasia	5	9.6
Squamous cell carcinoma	3	5.7
Typical carcinoid tumor	2	3.8
Adenocarcinoma in situ	2	3.8
Metastatic lung lesions	10 (5 colon, 3 rectum, 1 breast, 1 larynx, 1 bladder)	19.2
Benign histology	15	28.8

Table 2. Localization, the structure of nodules, histopathological diagnosis, and TNM stages of cases who underwent uVATS lobectomy.

	Histopathological diagnosis	Surgery	Pathological stage	Radiological density
1	Adenocarcinoma	Right lower lobectomy	pT1bN0	Solid
2*	Adenocarcinoma	Right middle lobectomy	pT1aN0	Ground Glass
3*	Typical Carcinoid	Right upper lobectomy	pT1aN0	Solid
4*	Typical Carcinoid	Right middle lobectomy	pT1aN0	Semi-solid
5*	Adenocarcinoma	Left lower lobectomy	pT1aN0	Ground Glass
6	Squamous cell carcinoma	Right lower lobectomy	pT1bN0	Solid
7*	Adenocarcinoma	Left lower lobectomy	pT1aN0	Semi-solid
8	Squamous cell carcinoma	Right lower lobectomy	pT1bN0	Solid
9	Adenocarcinoma	Right lower lobectomy	pT2N0	Solid
10	Adenocarcinoma	Right upper lobectomy	pT1bN0	Ground Glass
11	Squamous cell carcinoma	Left upper lobectomy	pT1aN1	Solid
12*	Adenocarcinoma	Right lower lobectomy	pT1aN0	Ground Glass
13	Adenocarcinoma	Left upper lobectomy	pT2N0	Solid

*Cases whose frozen results were uncertain but whose final pathology was evaluated as primary lung cancer.

Out of 39 cases who did not undergo anatomic resection, wedge resection was performed on the right upper lobe in 12 patients (23%), right lower in 12 patients (23%), left upper in 7 patients (13.4%), left lower in 7 patients (13.4%) and right middle in 1 patient (1.9%). Resection was completed with uVATS in all cases. Thoracotomy was not required in any case.

Of the 15 cases with ground glass nodules were resulted as 7 were lung adenocarcinoma (46.6%), 4 were atypical adenomatous hyperplasia (26.6%), 2 were benign (13.3%) and 2 were (13.3%) adenocarcinoma in situ. Of the 37 cases with solid or semi-solid features, 10 (27%) were metastatic, 14 (37.8%) were lung primary malignancies or precancerous, and 13 (35.1%) were benign.

Mean follow-up time with drain after the operation was 1.9 ± 1.2 days (1-5 days); the mean hospitalization time was 3.1 ± 1.3 days (1-7 days). Two (3.8%) cases have died after one year of follow-up. Pathology results of these cases were one of them was with extrapulmonary malignancy, and the other was benign. The 6-month survival rate was 100%, and the 1-year survival rate was 96.2%. One of the cases dead was oligo-metastatic advanced extrapulmonary malignancy, and the other one was a patient who has benign pathology but died of cardiac problems.

In malignant cases, the radiological (malignant: 9.51 mm benign: 7.40 mm $p = 0.038$) and pathological (ma-

lignant: 9.46 mm benign: 6.33 mm $p = 0.018$) sizes of the nodules were found to be significantly larger than the benign cases. No statistically significant correlation was found between whether the nodule was solid, semisolid, or ground glass and whether the nodule was malignant or benign. ($p = 0.232$)

Discussion

Diagnosis provides great prognostic benefits in cases with suspected primary pulmonary malignancy [7,8]. Performing VATS wedge resection for small or non-palpable lung nodules is a difficult procedure, especially for uVATS [9,10]. Suzuki et al reported the unfindable nodule rate as 63% without marking (diameter ≤ 10 mm or at a depth of more than 5 mm in the lung parenchyma) [11]. Correct preoperative marking not only increases the efficacy of the surgery but also helps the pathologist to identify the lesion in the resected specimen [8]. For this reason, various marking methods are used as hook wire, methylene blue, spiral wire, bronchoscopic barium marker, colored collagens, micro coil (especially in pediatric cases), lipiodol marker, and fluoroscopy, Tc99-labeled albumin macroaggregates [12-14]. The most important advantages of methylene blue compared with the other methods are low cost, easy to find, and easy to apply. [7,8]. In this study, regardless of the size of the semisolid or ground glass nodules and their distance from the visceral pleura, we marked all the cases with methylene blue under CT guidance just before surgery.

In this study, the mean nodule size was 8.85 mm. The mean distance of the nodules to the visceral pleura was 9 mm. The technical success of our study was 100%, and the diagnosis was obtained from all cases after the final histopathological examination. This result is similar to other studies in the literature [8,15,16]. The disadvantages of marking with methylene blue are its rapid diffusion and poor visibility in severe anthracosis lung [8]. The time between marking and surgery should be kept below 120-150 minutes to get the highest efficiency from methylene blue marking [17]. Therefore, the operations are performed immediately as soon as possible after marking with methylene blue. During the marking, a surgeon of the surgical team accompanied the interventional radiologist, making sure that the appropriate amount of methylene blue is given to the appropriate localization. Cases with invisible methylene blue marking according to anthracosis lung, Chiba needle entry hole or air bubble should be visualized in the lung parenchyma by performing an air leak test. In this study, the marking was completed in as little as 17 minutes. In this way, complications such as pneumothorax, hemorrhage, and pain were seen at a lower rate and the procedure could be completed more safely.

Many studies have compared the marking technique with methylene blue and hook wire which is the second most commonly used method [18,19,20]. Chu et al showed that the marking procedure with methylene blue was performed in a shorter time, and surgery time and hospitalization were reduced. In this study, the mean time from the beginning of the surgery to the end of the wedge resection was 20 ± 6.8 min. The mean hospitalization time was 3.1 ± 1.3 days. Also, the rate of complications such as hemoptysis and pneumothorax were lower in methylene blue, compared with hook wire. In this study, the pain was the most common complaint and pneumothorax was the most common complication. Chu et al reported that the administration of tissue adhesive with methylene blue reduces the risk of hemoptysis and pneumothorax [18]. The major limitation of our study is that we are not able to compare methylene blue administration with the other methods.

Another advantage of using the marking method at semisolid or ground glass lesions (which have highly malignancy rate) is diagnosing and resectioning the lesion in an early stage with uVATS. Ground-glass lesions may be due to benign causes such as hemorrhage, pneumonia, and fibrosis, or malignant histopathology,

especially early-stage lung adenocarcinoma or precancerous adenocarcinoma [21]. Ha et al reported that 81% of ground glass lesions were bronchoalveolar carcinoma or precancerous histopathology [22]. In this study, 86.6% of the ground glass lesions were adenocarcinoma or precancerous-noninvasive pathology. In this study, the radiological and pathological sizes of the malignant nodules were found to be significantly larger than the benign nodules. In this study, we terminated the operation with wedge resection if the frozen result is uncertain. In cases with final pathology as primary lung cancer, we performed a second surgery for complementary lobectomy and mediastinal lymph node dissection. Considering this possibility, unnecessary dissection must be avoided during frozen waiting for the need for a safe second surgery, especially uVATS.

The major limitation of our study is that we did not compare methylene blue administration with the other marking methods.

In conclusion, using the marking method, it is faster and easier to detect the localization of the nodule, and resection is possible with VATS. In this way, morbidity, unnecessary thoracotomy, and parenchymal resection are reduced. Through VATS, the postoperative period is more comfortable for the patient. In addition, drain follow-up and hospital stay are shortened compared to thoracotomy.

Methylene blue is more advantageous than other marking methods, as it is the cheapest, easiest to reach and apply, and least complicated marking option. It should be the first choice to be used for the percutaneous pulmonary nodule localization method.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

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Ethics approval

Approval was obtained from the Local Ethics of Dokuz Eylül University Committee (29.06.2022, 2022/22-42).

Authors' contribution

VK; conceptualized and drafted the article, wrote the paper FM,KCT; drafted the article, collected and analyzed data, İK; collected data, AG; marking the nodule, DG; pathologic analysis.

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Original Article

Importance of simulation devices in thoracic surgery education: a prospective comparative study

 Celal Bugra Sezen,  Gamze Tanrikulu,  Mustafa Vedat Dogru*,  Semih Erduhan,  Yasar Sonmezoglu,  Volkan Erdogan,  Nisa Yildiz,  Ozkan Saydam,  Muzaffer Metin

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ABSTRACT

Background: This manuscript aims to evaluate VATS lobectomy simulation training and the success of surgeons who have just started on simulation.

Materials and Methods: In the study, which was designed prospectively, we used a VATS simulation device to evaluate two expert surgeons and three residents' VATS right upper lobectomy outcomes. Forty-five resections were performed by residents (Group-A), while 43 resections were performed by expert surgeons (Group-B).

Results: 45 (51.1%) were in Group-A, and 43 were in Group-B. 78 (88.6%) successful resections were completed in simulation. The division and stapling time of the bronchus, superior pulmonary vein, and superior pulmonary artery was shorter for Group-B than for Group-A ($p < 0.05$). Eight resections (17.8%) could not be completed in Group-A due to complications, while in Group-B, two resections (4.7%) were incomplete due to complications ($p = 0.090$).

Conclusions: Based on this study, we believe that the experience of novice surgeons can be increased, especially with simulation training. Completion of similar operations also showed good content validity, especially when compared with experienced surgeons.

Keywords: VATS, stimulation, thoracic surgery, lobectomy, lung resection

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Introduction

Video-Assisted Thoracic Surgery (VATS) approaches have been performed in lung resections since the 1990s [1]. Nowadays, minimally invasive surgery is preferred over open surgery in lung cancer operations, and new developing technologies change surgeons' vision into minimally invasive surgery. VATS and robotic-assisted thoracic surgery (RATS) have become the most popular approaches in lung cancers surgery. Compared to open surgery, its earlier discharge, less pain, and complication rates, faster return to daily activities, reduced cytokine release, and economic advantages are more prominent, particularly, in minimally invasive approaches [1-3].

Despite all the innovations in minimally invasive surgery, surgical resections performed with VATS take longer compared to open surgery. The most remarkable reason for this is the challenges encountered in learning the use of thoracoscopic instruments and camera and hand orientation in narrow spaces. Moreover, the training of constantly developing technological instruments and their adaptation for surgery make up one of the primary problems for surgeons. Thus, it is considered that training such as dry lab, wet lab, training box, simulation, and live surgery enhance the adaptation of surgeons to technology. Although there are publications on the importance of these trainings in the literature, comparative publications are quite limited.

Our aim in this manuscript is to evaluate VATS lobectomy simulation training and the success of surgeons who have just started on simulation.

Materials and Methods

The study, which was designed prospectively, was conducted between October and November 2021. We used the Symbionix VATS simulation device (USA Corporation, Cleveland, OH) in this study. Two expert surgeons and three residents performed VATS right upper lobectomy resections in this study. In this study, 88 right upper lobectomies were performed in the simulation environment. Forty-five resections were performed by residents (Group-A) while 43 resections were performed by expert surgeons (Group-B).

Group A consists of surgeons in their first year of physician residency and who have not previously per-

formed any lung resections on their own. Before the resection simulation, residents finished the training programs in the simulation, and expert surgeons guided them. Besides, upper lobectomy resection training was provided by expert surgeons in a simulation environment. Expert surgeons have performed more than 100 lung cancer resections in the last two years and have been routinely performing lung resections with VATS for seven years.

The ethics committee approval of the study was obtained from the local ethics committee of our hospital. (Ethics Committee Decision No: 2021-157)

Surgical Technique

In the Symbionix VATS simulation device, the surgeon can see the surgery in VATS surgeries from the standard viewing angle. Simulation allows operation with 3 ports. Surgeons evaluate the thoracic cavity with a camera at the level of the anterior axillary line. There was no variation or tumoral structures in the training module. Standard anatomical tissues are included in the simulation, and all vascular, parenchymal, and bronchial structures can be dissected and resected in the simulation device.

All procedures were conducted in the same way in the simulation. Operations were performed using the 3-port technique (Figure 1A). Surgical field exposure was adjusted benefiting from the 30-degree optical usage feature. First, the upper lobe pulmonary vein was dissected and excised with an endoscopic vascular stapler (Figure 1B). Subsequently, after the pulmonary arteries leading to the upper lobe were dissected and cut, the bronchus was turned, and the endoscopic parenchyma was cut with a stapler. Following the fissure was completed with the stapler, the program automatically puts the material into the endobag and removes it.

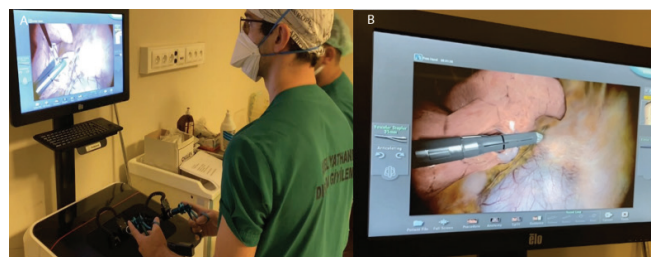


Figure 1. The simulation device (A), image of dividing the vascular structures with a stapler during the simulation (B).

Statistical Analysis

Statistical analyzes were performed using IBM SPSS for Windows version 22.0. Numerical variables were evaluated as mean and standard deviation or median, minimum, and maximum values; categorical variables were summarized using numbers and percentages. Parametric test assumptions (normality and homogeneity of variances) were checked before comparing numerical variables between the groups. Differences between groups were analyzed using the independent-samples t-test. Categorical values were analyzed using Fisher's exact test. Mann-Whitney U test was used to compare continuous variables. The level of significance was accepted as $p < 0.05$ for all analyzes.

Results

Of the 88 resections included in the study, 45 (51.1%) were in Group-A, and 43 were in Group B. 78 (88.6%) successful resections were completed in simulation training. The total duration of operation was determined to be 15.3 ± 6 min. The mean duration of the superior pulmonary vein (SPV) rotation and stapling was 4.5 ± 2.2 minutes. Besides, the mean duration of SPV ligation and stapling was 5.3 minutes (IQR: 4.1-7.3) in Group-A, while it was 3.1 minutes (IQR: 2.6-3.5) in Group-B ($p < 0.001$). The mean duration of the superior pulmonary artery (SPA) ligation and cutting with a stapler was 4.6 ± 2.8 min. While it was 7 minutes (IQR: 5-8) for SPA ligation and cutting with staples in Group A, it was 2.5 minutes (IQR: 2-3.5) in Group-B ($p < 0.001$). The mean time to ligate the upper lobe bronchus and cut it with a stapler was 4.4 ± 2.1 minutes. It was 6 (IQR: 5-7.4) in Group A, whereas it was observed to be 3 minutes (IQR: 2.4-3.5) in Group-B. A significant difference was found between the groups ($p < 0.001$). In Table 1, the operational characteristics of the groups are compared.

Table 1. Operational characteristics between groups.

Variables		Resident	Expert	p
Right Superior Pulmonary Vein Dissection (Min)	Median (IQR)	5.3 (3.3)	3.1 (0.9)	<0.001
Right Superior Pulmonary Artery Dissection (Min)	Median (IQR)	7 (3)	2.5 (1.5)	<0.001
Right Upper Lobe Bronchus (Min)	Median (IQR)	6 (2.5)	3 (1.1)	<0.001
Total Operation Time (Min)	Median (IQR)	19.8 (6.2)	8.7 (3)	<0.001

Abbrev.; Min: Minute, IQR: Interquartile Range

Eight resections (17.8%) could not be completed in Group-A due to complications, while in Group B, two resections (4.7%) were incomplete due to complications ($p = 0.090$). Complications occurred in a total of 15 (17%) resections. 12 (26.7%) complications occurred in Group-A. In Figure 2, the relationship between complication rates and case order in Group-A. Resection was successfully completed by intervening in 5 of these complications. While major vascular injury occurred in 9 (20%) patients in Group-A, major vascular injury developed in 3 (7%) patients in Group-B ($p = 0.098$). In both groups, one major vascular injury was successfully managed, and the resection was completed. The pericardial injury also occurred in 1 patient in Group-A who developed a major vascular injury. Table 2 shows the comparison of complications and groups. In Group-A, as the number of operations increased, the time of the operation decreased so they were mildly negatively correlated ($r = -0.499$) (Figure 3).

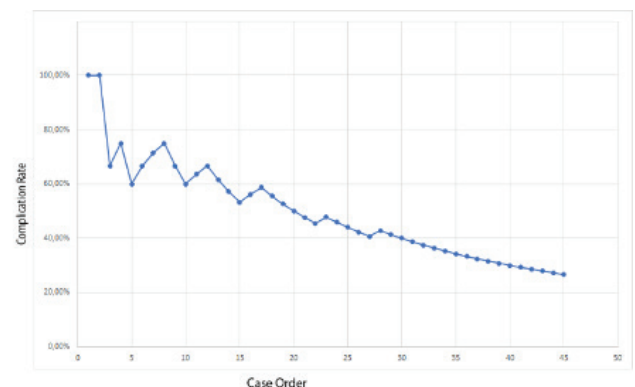


Figure 2. Relationship between complication rates and case order in Group-A.



Figure 3. Relationship between operation times and case order in successful resections in Group-A.

Table 2. Comparison of complications and groups.

Variables	Resident n (%)	Expert n (%)	P
Intraoperative complication	12 (26.7)	3 (7)	0.014
Major vascular injury	9 (20)	3 (7)	0.075
Phrenic nerve injury	3	0	1
Pericardium injury	1	0	1
Completing the resection	37 (82.2)	41 (95.3)	0.090

Discussion

Since uniportal surgical operations have become popular in recent years and resections with thoracotomy can be performed with uniportal surgery, many young surgeons have started performing VATS operations. Yet, the most remarkable problem is that VATS training is different from open surgery training and is relatively challenging. Although VATS has many advantages, major and mortal complications have been reported in the literature [4]. Young surgeons are discouraged, especially due to possible bleeding, and with the same concern, the willingness of specialist surgeons to have assistants perform these surgeries decreases. Hence, video thoracoscopic resections are performed in a limited number of centers in many countries as well as in our country [5]. We think that the most important reason for this problem in our country is the lack of VATS training programs.

There are different training programs regarding VATS and robotic surgery training in the literature [4,6-9]. In literature, there are publications suggesting that short-term observer programs are effective in education in centers with a high surgical patient volume, there are also authors who advocate step training models. Shioe et al stated that observers can be trained in a short time in training held in high-volume and experienced centers. Torre et al suggested that training on animal models is a good option for uniportal VATS lobectomy practice [10]. Rocco et al argue that if the opportunity for major resections is given, there will be more tendency toward minimally invasive surgery. We also consider that simulation training is crucial for residents who are new to VATS. We are of the opinion that the training is especially beneficial for residents to gain experience in VATS before the surgery and increase instrument coordination and 3D thinking.

Larsen et al revealed that virtual reality simulator training can reduce morbidity rates and shorten the operation duration [9]. Štupnik stated that surgical environments are not the best training areas since they are stressful places, and simulation training is important for the new generation of surgeons in this respect [11]. Solomon et al, on the other hand, developed an anatomy training model with a cognitive simulator made by surgical instruments on a haptic feedback device. They stated that thanks to this cognitive training model, the deficiencies in the existing training models can be corrected. Jensen et al. assessed the results of novice, intermediate and experienced surgeons in their LapSim virtual reality simulation training [12]. No difference was found between the groups in terms of the amount of bleeding, the duration of the operation, and the selection of the right instrument. As a result of the study in which 103 surgeons were included, they suggested that this simulation training is crucial to gaining experience in VATS. Furthermore, they stated that by improving the software, the differences between surgeons could be assessed more clearly. On the other hand, in the Haidar simulation study, a significant difference was found between the amount of bleeding, the duration of the operation, and the path length of the instruments between the experienced surgeon and the novice and intermediate surgeon [13]. In the study, they stated that novices passed the simulation test by practicing. Similarly, in the study of Tanaka et al on the wet-lung model, the procedures were performed successfully in both groups, though there were differences between the groups in terms of procedure times [14]. As a result of our study, we determined that novice surgeons successfully performed lobectomy after completing the simulation training. When compared with experienced surgeons, we did not find any significant difference between the groups. We observed that the most notable difference was the duration of the operation and the number of complications.

Likewise, Wan et al [15] have shown that trainees can safely perform VATS lobectomy under the supervision of experienced surgeons. Later, Peterson et al [4] stated in their study that TCs have a similar rate of morbidity to ECs. Training consultants also stated that

more prolonged air leaks were observed, and the operation time was longer. When complications in our simulation study were analyzed, it was noticed that major vascular injuries and mortality rates were higher in the resident arm. Whereas these rates were observed to be higher at the onset of the simulation training, we found that the complication and mortality rates decreased as we gained experience towards the end of the training. Moreover, we found that the operation durations and vein ligation times became shorter towards the end of the training. Based on this, we think that at the end of the training, especially VATS practice is more encouraging and contributes positively to motivation.

Limitation of the Study

The main limitations of the study include the inability to measure the amount of bleeding and the fact that it was performed by more than one surgeon, it was performed in a single center, and the instrument movements could not be calculated.

Based on the result of this study, we have come to a conclusion that the experience of novice surgeons can be increased, particularly through simulation training. Completion of similar operations also showed good content validity, especially when compared with experienced surgeons. We consider that VATS simulation training in thoracic surgery is an important cornerstone and should be applied in VATS training all over the world.

Declaration of conflicting interests

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Ethics approval

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Authors' contribution

CBS,OS,MM; conceptualized and drafted the article, CO-wrote the paper GT,MVD,SE; drafted the article, collected and analyzed data, YE,VENY; collected data.

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Original Article

Is it a coincidence that COVID-19 and pneumothorax coexist?

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ABSTRACT

Background: We aimed to investigate the relationship between COVID-19 and pneumothorax by examining patients who developed pneumothorax during the treatment of COVID-19 infection, and patients who were diagnosed with COVID-19 infection during hospitalization procedures due to pneumothorax.

Materials and Methods: We retrospectively analyzed patients who were hospitalized due to COVID-19 infection and developed pneumothorax, and patients who were hospitalized for pneumothorax with a positive COVID-19 test performed during hospitalization procedures, between May 2020 and January 2021. We recorded the demographic, clinical and radiological characteristics of the patients; treatment modalities, and response times to treatment. We investigated the relationship between COVID-19 infection and pneumothorax.

Results: Of the 25 patients included in the study, 20 (80%) were male and 5 (20%) were female. The average age was 45 (17-77). Sixteen (64%) had thoracic computerized tomography findings consistent with COVID-19. Bilateral pneumothorax was observed in three (12%) patients. Pneumothorax was seen in 7 (28%) patients during mechanical ventilation. Tube thoracostomy with wet suction control closed-drainage system was applied to all patients. The average length of stay in the hospital was 7.8 (3-20) days. Recurrent pneumothorax developed in two (8%) patients after discharge, while the mortality rate was 12%.

Conclusions: In patients with COVID-19 pneumonia, pneumothorax due to mechanical ventilation can develop, as well as pneumothorax can be observed even in asymptomatic COVID-19 cases. This condition needs immediate recognition and prompt treatment as a life-threatening event in COVID-19 patients.

Keywords: COVID-19, pneumothorax, SARS-CoV-2, tube thoracostomy

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Introduction

On March 11, 2020, WHO declared COVID-19 a pandemic due to the increased number of cases and countries affected and the risk of global spread. The clinical course of COVID-19 ranges from mild symptoms and even asymptomatic cases to severe illness [1,2].

Since the first COVID-19 cases were identified, pneumothorax has been considered a possible complication or association, although it is rare. In some retrospective studies on COVID-19, pneumothorax was observed in 1% of patients requiring hospitalization and in 2% of patients requiring intensive care unit admission [3,4]. A study conducted in 16 centers in UK compared the number of pneumothorax encountered during the pre-COVID-19 period with the COVID-19 pandemic period, and reported that pneumothorax could be a complication of COVID-19 infection, based on the number of pneumothorax that increased significantly during the pandemic period [3,5].

Pneumothorax is a life-threatening event that requires immediate diagnosis and treatment. If it occurs as a complication of an underlying lung disease, it is defined as secondary spontaneous pneumothorax. Pulmonary diseases associated with pneumothorax include emphysema, cystic fibrosis, granulomatous inflammation, necrotizing pneumonia, pulmonary fibrosis, eosinophilic granulomatous disease, lung cancer and sarcoidosis which cause fibrotic and/or cystic changes in the lung parenchyma.

Pneumothorax may also develop in mechanically ventilated patients due to high local pressure disrupting the lung tissue [6]. The use of mechanical ventilation is a risk factor for the development of pneumothorax in COVID-19 patients, and it has also been reported that pneumothorax is poor prognostic in COVID-19 patients undergoing mechanical ventilation [7]. However, there are studies showing that pneumothorax develops even in patients who do not have an underlying lung disease and do not need mechanical ventilation [5,8,9]. Although the mechanism of spontaneous pneumothorax of COVID-19 cannot be fully explained, it is thought to be associated with alveolar membrane damage [10,11].

We aimed to investigate the relationship between COVID-19 and pneumothorax by examining patients who developed pneumothorax while the treatment of COVID-19 infection was continuing, and patients who

were diagnosed with COVID-19 infection during hospitalization procedures due to pneumothorax.

Materials and Methods

This study is a single center retrospective study. The study was conducted in accordance with the principles of the Declaration of Helsinki. Written permissions were obtained for this study from the Scientific Study Committee and Republic of Turkey Ministry of Health. All patients with a diagnosis of pneumothorax who received treatment between May 2020 and January 2021, who had a positive COVID-19 PCR test result and/or had thoracic computerized tomography (CT) findings specific to COVID-19 infection were included in the study. Two patients who did not come for control after discharge and were not followed-up were excluded from the study. The demographic characteristics, comorbidities, smoking habits, clinical and radiological characteristics of the patients, the types of treatment applied, the response times to the treatment and the three-month follow-up period after discharge were recorded.

Results

Of the 25 patients included in the study, 20 (80%) were men and 5 (20%) were women and the average age is 45 (17-77). Eighteen (72%) had no history of additional disease. While 5 (20%) patients had diabetes, hypertension and/or coronary artery disease, only 2 (8%) patients had a history of chronic obstructive pulmonary disease (COPD). Twelve (48%) patients had no smoking history. Nine (36%) patients were active smoker and 4 (16%) patients were ex-smoker.

Nine of the patients (36%) had no CT findings compatible with COVID-19, and 16 (64%) had CT findings compatible with COVID-19.

Right pneumothorax was seen in 15 (60%) patients, and left pneumothorax in 7 (28%) patients; Bilateral pneumothorax was seen in 3 (12%) patients. The first pneumothorax attack was in 22 (88%) patients and only 3 (12%) patients had a history of previous pneumothorax. Pneumothorax was seen in 7 (28%) patients during mechanical ventilation. No mechanical ventilation was applied to 18 (72%) patients. Eight (32%) patients developed pneumothorax without any additional disease, smoking history or previous pneumothorax.

Tube thoracostomy was performed in all patients, and video-assisted thoracoscopic surgery (VATS) was

performed in 4 (16%) patients for prolonged air leak or recurrent pneumothorax. Average expansion time after tube thoracostomy was 3.2 (1-10) days. The average time for air leak was 4.76 (1-17) days. Tube thoracostomy termination time was 6 (2-20) days on average, but 3 patients who died when tube thoracostomy was not yet terminated were not included in this mean. The average length of stay in the hospital was 7.8 (3-20) days.

Recurrent pneumothorax developed in 2 (8%) patients after discharge, while the total mortality rate was 12%. The clinical and radiological characteristics of the patients, treatment methods applied, recurrence and mortality after treatment are summarized in table1 and durations related to treatment response and prognosis are summarized in table 2.

Table1. Clinical and radiological characteristics of the patients, treatment methods applied, recurrence and mortality after treatment.

	N=25	%
Gender		
Male	20	80
Female	5	20
Mechanical ventilation		
Yes	7	28
No	18	72
Finding about COVID-19 in CT		
Yes	16	64
No	9	36
Treatment		
TT	21	84
TT +VATS	4	16
Attack		
First	22	88
Recurrent	3	12
Mortality		
Yes	3	12
No	22	88

Abbrev.; CT: computerized tomography, TT: Tube thoracostomy, VATS: Video-assisted thoracoscopic surgery

Table 2. Average values of the times related to response to treatment and prognosis.

Air leak time (days)	4.76 (1-17)
Expansion time (days)	3.2 (1-10)
TT termination time (days)	6 (2-20)
Hospitalization time (days)	7.8 (3-20)

Abbrev.; TT: Tube thoracostomy

Discussion

Pneumothorax associated with severe acute respiratory syndrome coronavirus 2 (SARS- CoV-2) has been identified in the literature as a rare potential complication, with a rate of one percent in some studies examining patients with COVID-19 infection [3,4,12,13].

The mechanism of spontaneous pneumothorax in patients with COVID-19 infection is thought to be associated with alveolar membrane damage caused by cystic and fibrotic changes in the lung parenchyma [10,11].

This relationship may also be secondary to the underlying undiagnosed bullous lung disease [14]. Other possible trigger factors are mechanical ventilation and prolonged cough, which is a common symptom of COVID-19 disease [3,10,15]. McGuinness et al [7] reported a 15% rate of barotrauma, including both pneumothorax and pneumomediastenes, in patients undergoing mechanical ventilation . Aiodfi et al [16] reported two patients who developed pneumothorax during mechanical ventilation for COVID-19 pneumonia. Ucpinar et al [17] reported that some patients with COVID-19 developed pneumothorax associated with risk factors such as mechanical ventilation, while viral pneumonia itself as the only factor in the development of pneumothorax in some patients. A multicenter study reported that out of 1619 patients with a confirmed diagnosis of COVID-19, 22 (1.4%) observed spontaneous pneumothorax and 50% of patients were not mechanically ventilated when diagnosed with pneumothorax [9]. Similarly, in 18 (72%) of the 25 patients we examined in our study, no mechanical ventilation was applied. In a study conducted with 71 patients reported from 16 centers in England, they revealed the association of COVID-19 pneumonia and pneumothorax even in patients who had no previous lung disease and did not need mechanical ventilation [5]. Similar to the literature, our study showed that pneumothorax can be observed in asymptomatic COVID-19 cases, as well as patients with COVID-19 pneumonia can develop pneumothorax due to mechanical ventilation. As understood from the literature, most of the reported cases of pneumothorax associated with COVID-19 do not have traditional risk factors or underlying predisposing lung disease [17,18]. In our study, coexistence of COVID-19 pneumonia with pneumothorax was observed in 8 (32%) patients who did not have any additional disease, smoking history, or history of previous pneumothorax and who

were not mechanically ventilated. In the study conducted with 71 patients reported from 16 centers in England, they stated that pneumothorax was not an independent marker for poor prognosis in the coexistence of COVID-19 and pneumothorax [5]. However, there are also studies suggesting that this association is a serious prognostic marker [7,19,20]. In our study, three patients who developed pneumothorax while being followed up in the intensive care unit due to COVID-19 infection, rapidly worsening the general condition within two days and the death of these three patients support the view that pneumothorax is a poor prognostic for COVID-19 infection. In addition, prolonged air leak in four patients and recurrent pneumothorax development in two patients in the first month after discharge suggest that COVID-19 infection is a poor prognostic factor for pneumothorax. In our study, 36% of the patients had no thoracic CT findings compatible with COVID-19, suggesting that the asymptomatic COVID-19 infection in these patients may have been diagnosed incidentally due to spontaneous pneumothorax. In patients with suspected COVID-19, pneumothorax should be considered as a cause of acute decompensation that may worsen the prognosis. COVID-19 patients treated with non-invasive and invasive forms of mechanical ventilation require close monitoring, as the risk of ventilator-associated pneumothorax may be increased [21]. Management of pneumothoraces in these patients is very important to prevent the development of potentially life-threatening tension pneumothoraces. The limitation of our study is that it is a single center study and the number of patients is small. It is aimed to be a guide for more studies on the subject. Future multi-center studies are needed to better understand the relationship between pneumothorax and COVID-19, and to contribute to prognosis and treatment.

In conclusion, pneumothorax is a possible complication of COVID-19 pneumonia. It may develop due to mechanical ventilation or can be observed in asymptomatic COVID-19 cases and it should be considered in the differential diagnosis for COVID-19 patients who develop sudden respiratory decompensation. As a life-threatening event, it needs immediate recognition and prompt treatment.

Declaration of conflicting interests

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Ethics approval

Approval was obtained from the Local Ethics of

Authors' contribution

SB; conceptualized and drafted the article, wrote the paper MA,PE,SKM; drafted the article, collected and analyzed data, ALA,SVB; collected data.

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Original Article

Analysis of non-operative management of 53 thoracic gunshot injuries in a training hospital from a thoracic surgical perspective

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ABSTRACT

Background: Although clinicians use selective non-operative control of thoracic gunshot injuries (TGSI), parameters that may affect the clinical response have not been studied. The aim of this study is to determine the safety and clinical outcome of non-operative follow-up of TGSIs.

Materials and Methods: Demographic, radiological and clinical features of 53 TGSIs, 2 female and 51 male, who were followed conservatively were examined. The data from the patients were retrospectively studied in terms of age, gender, extra-thoracic organ injuries, duration of chest tube, and length of hospital stay.

Results: Median age was 24. Twenty patients had extrathoracic injury (%37.7). The presence of extrathoracic pathology did not affect the total length of stay, but the diameter of hemothorax, pneumothorax or contusion did. No correlation was observed between the length of stay of the chest tube and the Thoracic Trauma Severity Score (TTSS) or Injury Severity Score (ISS) of the patients ($p = 0.756$, $p = 0.160$). No correlation was observed between the diameter of the contusion area and the TTSS score or ISS score ($p = 0.672$, $p = 0.201$).

Conclusions: Thoracic gunshot injuries can be approached conservatively by close monitoring and being aware of all life-threatening conditions. While trauma scores are quite adept at predicting length of stay, they do not always correlate with trauma severity.

Keywords: gunshot wounds, chest, penetrating trauma, selective nonoperative management.

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Introduction

In trauma cases where many regions are affected at once, including vital organs, thoracic involvement is an indicator of the severity of the trauma. Blunt thoracic traumas are more common than penetrating traumas; however, in examining the trends of penetrating traumas, the rate of firearm injuries has increased in recent years [1]. Tissue damage in gunshot wounds is not limited to the trajectory of the bullet. The ballistic waves it creates in direct proportion to the kinetic energy hitting the body are transmitted by the parenchyma and cause ruptures and cavitations in neighboring tissues, resulting in an increased area of tissue damage [2]. In thoracic traumas, since the chest wall is affected most frequently (70%), conservative methods are sufficient to treat most patients. Only 15% to 30% of penetrating traumas require major procedures [3]. However, information regarding the prognosis of conservatively managed gunshot thoracic injuries is limited [4]. Knowledge of this field is mostly determined by clinical foresight. Thus this study aimed to analyze thoracic gunshot injuries with trauma scores to define treatment strategies and determine the effectiveness of conservative treatment and prognosis.

Materials and Methods

Data of patients who were treated for thoracic gunshot wounds in Gulhane Education and Training Hospital, between June 2000 and October 2021 were analyzed retrospectively. The study was approved by the institutional ethics committee (December 16, 2021, 2021-413). The thoracic cavity is defined as the cavity surrounded by the thoracic vertebrae, ribs, and sternum and the muscles that cover them, bounded below by the diaphragm and superiorly by the aperture thoracica superior. Patients who presented to the emergency department, who underwent surgery, and whose files could not be obtained were excluded from the study. Only patients with thoracic gunshot injuries treated without surgery were included in the study. All patients underwent abdominal and thoracic computed tomography (CT) during their first admission. Cerebral CT, extremity CT, and direct radiography were also performed when required. The largest contusion diameter was measured on the

first thorax CT scans. If there are two or more contusions, the diameter of the larger one is taken. Patients with penetrating cardiac, vascular, or diaphragmatic injuries were excluded. Eleven patients were excluded because their injuries only involved the muscle layer of the thorax but not intrathoracic organs. Ten patients died within an hour of arrival in the emergency department, so they were not included in the study. Finally, 53 patients with thoracic gunshot injury were reviewed.

Data from the patients were retrospectively studied in terms of age, sex, injury site (left, right, and bilateral), extrathoracic organ injuries, chest tube duration (day), length of hospital stay (day), and need for intensive care unit (ICU) stay or surgery after follow-up. The injury severity score (ISS) was defined by Baker et al. to classify patients with blunt and penetrating traumas [5]. In the ISS, wounds are scored from 1 (minimum severity) to 6 (maximum severity, almost always fatal) for seven anatomical regions (head and neck, face, chest, abdomen, extremity, and external) (Table 1). An injury with a magnitude of 6 in any region constitutes an ISS of 75. The thoracic trauma severity score (TTSS) provides prognostic information by evaluating patient data against anatomical and physiological data. A score of ≥ 7 has been associated with increased morbidity (Table 2) [6]. The recovery criteria were as follows: absence or minimal pain with adequate analgesics; ability to take in food orally; absence of abdominal discomfort, nausea, or vomiting; ability to void, dress, and ambulate; and absence of fever or tachycardia, finding or complaint indicating any pathology, requirement of additional blood transfusion, and gross increase in contusion. The patients were discharged from the hospital when their general condition was stable and by their own will.

Table 1. The Injury Severity Score (ISS).

Body region	Score	Injury severity
Head and neck	1	Minor
Face	2	Moderate
Chest	3	Serious
Abdomen	4	Severe
Extremity	5	Critical
External and other	6	Maximal (untreatable)
<i>The ISS can range from 0 to 75. It is obtained by adding the squares of the scores of the 3 highest scoring regions.</i>		

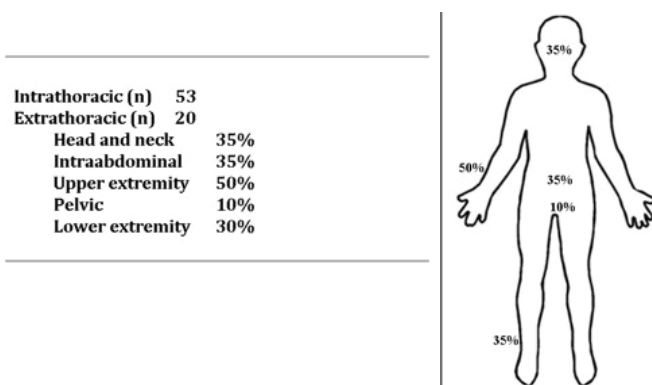
Table 2. The Thoracic Trauma Severity Score (TTSS).

PaO ₂ /FiO ₂	Rib fracture	Contusion	Pleural involvement	Age (years)	Points
<400	0	None	none	<30	0
300-400	1-3	1 lobe	PT	30-41	1
200-300	4-6 unilateral	1 lobe bilateral or 2 lobes unilateral	Unilateral HT or HPT	42-54	2
150-200	>3 bilateral	<2 lobes bilateral	HT or HPT bilateral	55-70	3
<150	Flail chest	≥2 lobes bilateral	Tension PT	>70	5

Abbrev.: PT, pneumothorax; HT, hemothorax; HPT, hemopneumothorax

Results

Over 20 years, 145 gunshot injuries, with thoracic involvement, were recorded, and 53 of them were healed with a non-operative approach. Moreover, 51 of the 53 patients were male and two were female. The median age was 24 (15-60) years. Two of the gunshot injuries were attempted suicide. Rib fracture was observed in six patients, whereas sternal fractures were observed in two patients. Hemothorax, pneumothorax, and hemopneumothorax were identified in 40, 39, and 36 patients, respectively. Twenty (37.7%) patients had extrathoracic injuries. Two patients had pathologies that required intensive care indication. Patient demographics and injury characteristics are outlined in Table 3. The distribution of gunshot injuries is detailed in Figure 1. The length of stay was not different between those with and without extrathoracic pathology ($p = 0.336$). Hospitalization and tube thoracostomy time were significantly longer in patients with hemothorax or pneumothorax than those without ($p < 0.01$). The diameter of the contusion created by the firearm was not different between patients with and without hemothorax and patient with and without pneumothorax ($p = 0.591$, $p = 0.904$).

**Figure 1.** The distribution of gunshot injuries.

Parameters such as contusion diameter, hemothorax, pneumothorax, TTSS, ISS score, age, and sex were not different from each other in the group with and without tube insertion. The mean TTSS was 3.79 ± 0.256 , and the median ISS score was 16 (4-36, IQR = 11). Age, TTSS, and ISS score were not correlated ($p = 0.903$, $p = 0.245$). A chest tube was inserted in 39 patients. There was no need for two or more chest tube insertions in any patients. No correlation was observed between the length of stay and chest tube duration ($p = 0.756$). No correlation was found between the TTSS and ISS scores ($p = 0.160$). TTSS and ISS scores were significantly different from each other in patients with and without tube insertion (both $p < 0.01$). A significant positive correlation was found between the total length of stay and their TTSS and ISS scores ($r = 0.782$, $p < 0.01$ and $r = 0.582$, $p < 0.01$, respectively) (Figure 2). No correlation was observed between the diameter of the contusion area in the lung and the TTSS or ISS score ($p = 0.672$, $p = 0.201$). Moreover, no correlation was observed between the chest tube duration and the diameter of the lung contusion ($p = 0.624$). The contusion diameter was also not correlated with the total hospital stay ($p = 0.705$). The number of rib fractures and chest tube duration were not correlated, but the number of rib fractures positively correlated with the total length of stay ($p = 0.025$, $r = 0.308$). The number of rib fractures was also positively correlated with the TTSS ($p = 0.006$, $r = 0.376$). A positive correlation was found between TTSS and ISS ($p < 0.01$, $r = 0.605$). Only two patients required admittance to the ICU. Two complications occurred, i.e., sepsis and pneumonia. No mortality was recorded.

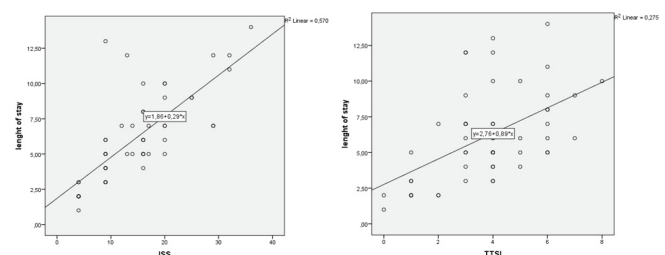
**Figure 2.** Shows the positive correlation between ISS and TTSS and length of stay.

Table 3. Characteristics of patients.

Age (median,range)	24(15-60)
Gender, number (male/female)	51/2
Extrathoracic injuries	20
Brain injury	7
Abdominal injury	7
Extremity injury	14
Thoracic injuries	53
Sternum fracture	2
Rib fracture	6
Pneumothorax	39
Hemothorax	40
Hemopneumothorax	36
Chest tube insertion (number)	39
Chest tube duration (day)	4.58
Length of stay ICU (day)	2.5
Length of stay hospital (day)	6.13
Mortality	0

Discussion

Serious thoracic injuries are the most common cause of trauma-related deaths [7]. Thoracic gunshot wounds require careful decision-making at every stage because of the damage and unexpected complications they cause. Having clearly defined indications for emergency surgery in patient management makes it easier for clinicians [8]. Furthermore, for hemodynamically stable patients, the boundaries for whom the wait-see approach can be applied are not clearly drawn. This study was conducted to facilitate clinicians in making tough decisions about their patients by investigating the epidemiology, characteristics, and non-operative management of thoracic gunshot injuries.

In this study, the rate of thoracic gunshot injuries treated without surgery was 36%. This rate is significantly higher than reported previously [8] because this hospital served as a military hospital in the first 15 years covered by the study, and patients who underwent surgery had considerably complicated injuries.

Hemothorax is one of the most common pathologies after thoracic gunshot wounds [9]. In our study, 40 (75.5%) patients had hemothorax, but we concluded that hemothorax was not associated with the destruction on the parenchyma. Since the bullet has a cauterizing effect on the parenchyma, hemothorax may not be seen in the absence of a thoracic wall or pulmonary vascular injury [10]. For hemothorax detected by CT, a clear rule has

not been specified regarding how much blood accumulation requires tube thoracostomy. Some clinicians find it appropriate to apply tube thoracostomy, even in small amounts [9]. Resorption capacity is individualized and depends on additional pathologies. Therefore, whether tube thoracostomy should be performed is a patient-specific decision, considering additional pathologies. In patients with minimal hemothorax and stable hemodynamics, tube insertion is not needed in cases without intrathoracic organ injury and bleeding. Close follow-up is essential, even if the initial drainage amount is not alarming in patients with tube placement.

If hemothorax is accompanied by pneumothorax, our approach is to perform tube thoracostomy regardless of the extent of pneumothorax. Considering that the differences in the amounts of lung contusion in gunshot injuries and lung capacity will decrease, tube thoracostomy is recommended for hemopneumothorax. However, isolated pneumothorax cases, i.e., without or with minimal hemothorax and does not cause dyspnea, can be followed without tube thoracostomy [11].

TTSS and ISS scores were different from each other in groups with and without both hemothorax and pneumothorax. Despite the lack of tomography imaging in these scoring systems, it is proved to be adept at determining the severity of injury.

Patients with hemothorax or pneumothorax significantly had longer length of stay. Respiratory symptoms also vary because the lung capacity will be different for each patient. However, a median of the total length of stay of 6 days is acceptable. Because the length of stay was not different between those with and without extrathoracic pathology, it can be concluded that the main factor affecting the total length of stay is the severity of the injury.

Scoring systems should be easy to implement without losing time [12]. Therefore, using anatomic scoring systems that do not consider physiological parameters is convenient for ease of use, but it may be insufficient in estimating mortality and morbidity because of the uncertainty of physiological heart and lung capacity information. Moreover, the three sites with the highest ISS scores are considered, and there is an opinion that the expected morbidity and mortality in a region is underestimated when other injuries are ignored [12-15]. A score of >20 is

an indicator of a poor prognosis. In our study, 16 patients had a score of ≥ 20 points. Only nine patients had an ISS score of < 9 . Despite its shortcomings, ISS is widely used and has been associated with mortality and length of hospital stay. Furthermore, a thoracic gunshot injury results in the patient's score being evaluated as 25 of 75 overall.

TTSS also considers functional capacity because of its parameters. It can also be easily calculated even with a chest X-ray alone, providing valuable information for the quick estimation of mortality and morbidity. A TTSS of < 9 is classified as minor trauma. In our study, the mean TSSS was 3.79 ± 0.256 , and the highest score was 8.

In the TTSS system, the only parameter detected by imaging is the presence of a contusion. However, the contusion diameter of our patients was not correlated with the TTSS. This finding indicates that the lung capacity of a patient and the tolerance level to damage caused by the contusion are more important in determining the severity of the damage. The finding that the total length of stay is not affected by the contusion diameter supports this finding. In the future, we think that combining lung-specific trauma scores with a biological marker reflecting the respiratory reserve of the individual, such as surfactant protein D, will yield more accurate results [13]. As expected, hemothorax or pneumothorax increases the patient's trauma score and prolongs hospital stay [8]. Extrathoracic organ injury has been reported in 75% of thoracic traumas [14,15]. In this study, this rate was 37.7%. Thoracic areas are of great importance in the estimation of mortality and morbidity.

In conclusion non-operative management of hemodynamically stable thoracic gunshot injuries with careful monitoring is effective and safe. Trauma scores calculated at the first sight are successful in estimating the results, but they may not accurately reflect the severity of trauma because of personal differences in respiratory capacity; thus, clinical decisions should be made accordingly. In the future, there is a need to develop trauma scoring systems combined with biochemical markers that reflect individual respiratory capacity.

Declaration of conflicting interests

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Ethics approval

Approval for study was obtained from the Clinical Research Ethics Committee of Gulhane Training and Research Hospital (16/12/2021, 2021-413) .

Authors' contribution

MSI; conceptualized and designed the study. UU, visualization, data presentation. MSI, HI, UU collected and analyzed data. AG, HC, ES, KK; revised the final version of the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work

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Original Article

Single center experience of war-related thoracic injuries in Syria

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ABSTRACT

Background: The Syrian civil war caused serious deaths and injuries. Thoracic surgery has shown its effectiveness in this war as it is a war surgery. In this study, we aimed to analyze and convey our experience with 47 war-related chest trauma patients to describe the chest trauma profile and determine the predictive morbidity and mortality.

In this study, we aimed to analyze and convey our experience with 47 war-related chest trauma patients to describe the chest trauma profile and determine the predictive morbidity and mortality.

Materials and Methods: From 2012 to 2017, 47 consecutive patients underwent surgical treatment for chest trauma at the Gaziantep University Hospital, in Turkey. The demographic and relevant clinical information was retrospectively collected from the hospital records. Data included mechanism of injury, gender, age, findings, treatment modality complications, length of hospital stay, morbidity, and mortality. Injuries were classified as penetrating (gunshot or shrapnel wounds) and blunt injuries.

Results: The average age of patients was 25.4 years (range, 4 to 43 years) and 40 patients were males (85%). Sadly, 6 patients were under 18 years old. 41 patients (87.2%) with penetrating and 6 (12.8%) with blunt injuries. The most penetrating injuries to the chest were caused by shrapnel (61.7%). Eleven patients had already had emergency thoracotomy in another hospital before admission. In our study, 28 patients had pneumothorax, and 22 patients had hemothorax (Some patients have multiple diagnoses). However, there were 26 (23.64%) lung contusions in patients. No surgery-related deaths or major morbidity occurred. So, in all cases, the mortality rate was 2.13%.

Conclusions: Intervention in thoracic trauma patients is lifesaving and satisfying compared to other system injuries. Most thoracic injuries can be treated with tube thoracostomy and conventional therapy.

Keywords: war, thoracic injury, surgery, trauma, penetrating injury, blunt injury

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Introduction

The Syrian civil war caused serious deaths and injuries. Thoracic surgery has shown its value in this war. Necessary interventions and treatments were carried out on patients from neighboring Syria, which has deficiencies in terms of equipment.

Thoracic trauma is a major cause of morbidity and mortality in urban trauma centers [1]. Trauma is known to be the leading cause of death in the first four decades of life [1]. Thoracic traumas constitute a significant part of trauma-related deaths, but when all trauma numbers are considered, it is in third place after cranium and limb traumas [2]. Chest trauma is the most common cause of traumatic death in the United States after head trauma, accounting for approximately 20% of deaths [1,3]. Thoracic trauma includes injury to the chest wall, tracheobronchial tree, lungs, diaphragm, esophagus, heart, and great vessels. The overall profile of chest injuries varies widely between different centers [4]. Most chest trauma can be managed without thoracotomy [5]. Aggressive management of the pulmonary system and prompt treatment of associated injuries is essential for optimal patient outcomes [6].

In a study of military emergency departments in Iraq and Afghanistan from January 2007 to August 2016, the most common mechanism of injury was explosives (55.3%), followed by gunshot wounds (23.6%) [7]. In these patients, hemorrhage was the most frequent cause of death, followed by a compromised airway. In a study examining battlefield fatalities from October 2001 to June 2011, torso hemorrhage accounted for 61.2% of 976 preventable deaths [3]. During the war in Iraq, a thoracic injury occurred in 10% of casualties and related mortality was around 10% [8].

In this study, we aimed to analyze and convey our experience with 47 war-related chest trauma patients admitted to Gaziantep University hospital to describe the chest trauma profile and determine the predictive morbidity and mortality.

Materials and Methods

Data Analyses

From 2012 to 2017, 47 consecutive patients underwent surgical treatment for chest trauma at the Gaziantep University Hospital, in Turkey.

The demographic and relevant clinical information was retrospectively collected from the hospital records. Data included mechanism of injury, gender, age, findings, treatment modality complications, length of hospital stay, morbidity, and mortality.

Injuries were classified as penetrating (gunshot or shrapnel wounds) and blunt injuries. Diagnosis classi-

fied as contusion of the lung, injury of blood vessels of the thorax (including thoracic aorta), injury of the heart (pericardial), traumatic pneumothorax, traumatic hemothorax, injury of thoracic trachea, injury of diaphragm, injury of lymphatic thoracic duct, injury of esophagus (thoracic part), injury of brachial plexus.

Management

The initial management of the trauma patients was carried out in the emergency room. The Advanced Trauma Life Support protocol was followed for all patients. The primary and secondary surveys were performed. Most patients had lateral cervical spine, pelvic, and chest radiographs. Computed tomographic scanning of the head, abdomen, and chest; ultrasonography; echocardiography; bronchoscopy; and esophagoscopy were performed as indicated. The orthopedic, neurosurgical, abdominal, or chest surgical interventions were performed when indicated.

The operation (if required) was performed under general anesthesia using a single/double-lumen endotracheal tube. Chest tubes were removed after 24 hours with no air leak, less than 150 mL of fluid discharge, and a complete expansion of the lung. Approval was obtained from the respective institutional review boards before commencing the study.

Statistical Analysis

Continuous variables such as age and length of hospitalization were expressed as mean $\pm$ standard deviation and analyzed by the two-sample t-test. All statistical analyses were performed with SPSS 25 for Windows.

Results

The mean age of patients was 25.4 years $\pm$ 9.4 SD (range, 4 to 43 years). 40 patients were males (85%). Sadly, 6 patients were under 18 years old. Eleven patients had already had emergency thoracotomy in another hospital before admission. These patients' surgery aimed to control hemorrhage due to hemothorax and great vessel injury.

The mechanisms of injury in patients are shown in table 1. The most penetrating injuries to the chest were caused by shrapnel (61.7%)

Table 1. Mechanisms of injury in patients with thoracic trauma.

Dominant mechanism	N (%)
Penetrating trauma	41 (87.2)
Shrapnel	29 (61.7)
Gunshot wound	12 (25.5)
Blunt trauma (due to explosion)	6 (12.8)

The number of each thoracic trauma injury seen in patients is shown in table 2. As multiple diagnoses, there were 45.45% pneumothorax, hemothorax, or both in patients.

The management of 47 cases of chest injury is shown in table 3. Video-assisted thoracic surgery was performed on 1 patient with shrapnel near the aorta. Bronchoscopy was done in only 1 patient due to a gunshot bullet in the main bronchus. In 6 cases, primary closure was performed after debriding broken ribs and necrotic tissues. No graft was used in thoracic wall reconstruction.

5 cases were operated on together with cardiovascular surgery. One case was taken to dialysis after a nephrology consultation due to crush syndrome. One case was followed up by obstetrics because of being pregnant. One case had a maxillofacial fracture and was followed up by otolaryngology.

Late complications of the initial injury or subsequent treatment occurred in only 4 cases (8.5%). Two cases with a prolonged air leak were cured with conservative treatment. One case with tracheoesophageal fistula was cured with an esophageal and tracheal stent. One case with mediastinitis was cured with drainage and medical treatment. The mean length of hospitalization was at 12 days.

No surgery-related deaths or major morbidity occurred. One patient died 35 days after admission; the causes of death in this patient included broncho-biliary fistula, hypovolemic shock, and sepsis. Thereby, in all cases, the mortality rate was 2.13%.

Table 2. Rates of thoracic trauma types.

Diagnosis (ICD 11)	N	%
Traumatic pneumothorax	28	25.45
Traumatic hemothorax	22	20.00
Contusion of the lung	26	23.64
Injury of the thoracic trachea	4	3.64
Injury of the esophagus (Thoracic part)	4	3.64
Injury of blood vessels of the thorax (including thoracic aorta)	5	4.55
Injury of the diaphragm	1	0.91
Injury of the heart (Pericardium)	3	2.73
All chest wall traumas	6	5.45
Injury of the brachial plexus	1	0.91
Bronchopleural fistula	1	0.91
Injury of the thoracic duct	1	0.91
Parenchymal laceration	7	6.36
Bronchobiliary fistula	1	0.91
Total*	110	100

*Some patients have multiple diagnoses.

Table 3. Management of cases.

Procedure	N	%
Foreign body removal (bullet/shrapnel)	15	24.19
Conservative treatment	13	20.97
Lung parenchyma repair	7	11.29
Chest wall reconstruction	6	9.68
Great vessel repair	5	8.06
Chest tube insertion alone	4	6.45
Esophagus repair	4	6.45
Trachea resection and reconstruction	3	4.84
Pericardial window opening	3	4.84
Diaphragm rupture repair	1	1.61
Ductus thoracicus ligation	1	1.61
Total	62	100

Discussion

Our study reports our war-related thoracic injury experience with patients' surgical treatment of blunt and penetrating chest injuries.

Thoracic injuries are among the most severe forms of trauma and a leading cause of morbidity and mortality centers [1]. Some patients sustain severe solitary or multiple injuries and arrive at the hospital in an unstable status. After a meticulous clinical and imaging evaluation, some patients require early surgical intervention to complete the investigation or treat the intrathoracic injury. In the literature, tube thoracotomy and exploratory thoracotomy were the only therapeutic modalities [9]. Kandahar et al, in 1354 disease study, applied to the emergency trauma center in 2007, only cases of thoracotomy were applied to 18%. The number of patients undergoing thoracotomy was reported as 2.6% [10]. Our study required thoracotomy in 11 cases (23.4%).

Thoracic trauma is a notable cause of morbidity and mortality in American trauma centers, where 25% of traumatic deaths are related to injuries sustained within the thoracic cage [4]. These data and a review of the literature confirm that in patients with chest trauma. We strongly believe that these death rates will be reduced with new applications in the modern management of trauma.

Patients who develop hemopneumothorax after chest trauma are followed up after tube thoracotomy. In case of an increase in hemothorax or pneumothorax and meeting the criteria of emergency thoracotomy, the patient is treated with thoracotomy [11,12]. We also operated on patients with emergency thoracotomy indications after chest tube application.

Most authors agree that patients with the best outcomes are those with the following features: isolated chest injury; single versus multiple chest injuries; penetrating rather than blunt mechanism; stab wounds rather than gunshot wounds; vital signs on presentation; and prehospital intubation [4,13]. The most penetrating injuries to the chest were caused by shrapnel. Eleven patients required emergency thoracotomy in the operation room of another hospital before admission. These patients' surgery aimed to control hemorrhage due to hemothorax and great vessel injury.

Several previous studies have also suggested that thoracotomy in the OR (operation room) results in a better outcome, although this is related to patient selection [4,6]. Finally, varying definitions of what constitutes an "ER (emergency room) resuscitative thoracotomy" as well as differences in patient populations and prehospital systems confound generalizations [14,15].

The most common chest injuries identified were pneumothorax, pulmonary contusion, and chest wall trauma (including rib fractures). This pattern agrees with the Propper et al report [16]. This study aimed to determine the incidence and mortality of combat-related thoracic trauma (CRTT) and identify factors associated with mortality. We conclude that most chest injury patients can be managed conservatively with observation and tube thoracotomy. In our series, 23.4% percent of the injuries were treated successfully by either single or double tubes. Minimal pneumohemothorax was treated by close observation, repeated chest X-ray films, and antibiotics. Late complications of the initial injury or subsequent treatment occurred in only 4 cases. The mean length of hospitalization was at 12 days. No surgery-related deaths or major morbidity occurred. One patient died 35 days after admission; the causes of death in this patient included broncho-biliary fistula, hypovolemic shock, and sepsis. So, in all cases, the mortality rate was 2.13%.

We think that one of the reasons for the high success of the treatment is that not all cases can be referred to us. As stated in the article, thoracotomy was performed in some cases in another center and tube thoracostomy was performed in some cases. Some cases may have died before they can be referred to us in another center. This was the limit of our study.

In conclusion, most thoracic injuries may be treated

with tube thoracostomy and conventional therapy. Thoracotomy is indicated for severe bleeding, chest wall damage, and heart and esophagus injuries. However, intervention and referral to patients with thoracic trauma during the war should be fast and effective. Intervention in thoracic trauma patients is lifesaving and satisfying compared to other system injuries.

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Ethical approval

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Authors' contribution

AU; conceptualized and designed the study. IET; data presentation. MS; collected and analyzed data. AU, IET, MS, AFI; revised the final version of the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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Original Article

Analysis of erroneous appointments from the thoracic surgery outpatient clinic of a training hospital

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ABSTRACT

Background: Applications of patients to the outpatient clinics of health institutions are not subject to any control and are left to the patient's choice. System is confused by patients, especially in close specialties, and patients make appointments from the outpatient clinic, which is unrelated to their complaints. Likewise, a group of patients does not come to arbitrary appointments. Making an erroneous appointment or failing to attend an appointment causes a serious loss of time for physicians and other patients. Appointments from an outpatient clinic not related to the disease. In our study, the data of patients who made an incorrect appointment from our outpatient clinic in the last one year and did not come to their appointment were analyzed retrospectively.

Materials and Methods: The data of patients who made an incorrect appointment from our outpatient clinic and did not come to their appointments within a year using central physician appointment system were analyzed retrospectively.

Results: Of 1482 patients who made an appointment through the central physician appointment system, 278 (18.8%) did not come to their appointment. 128 (8.6%) patients had an incorrect appointment.

Conclusions: Organizing outpatient clinic appointments through the central system aims to enable patients to reach the service more easily and to benefit from the outpatient clinic service at a time convenient for them. It is a common situation that patients do not come to their appointments or make an incorrect appointment, causing unnecessary loss of workforce and the inability of other patients who request outpatient services to get an appointment.

Keywords: thoracic surgery, outpatient clinic, central physician appointment system, erroneous appointments.

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Introduction

Outpatient healthcare constitutes an integral part of diagnostic and therapeutic services provided to ambulatory patients, and the service procedures and principles for such units are specified in regulations [1-3]. In recent years, the central physician appointment system (CPAS; in Turkish: MHRS) has been established and used to provide easier outpatient care access, prevent queues at the hospital, ensure better examinations, and other similar purposes [3]. Although this system has many advantages, it has also demonstrated various disadvantages, such as no-show to appointments or erroneous selection of appointments for clinics that are unrelated with the disease or complaint. Many of these disadvantages are clinic-specific. For instance, it is a known fact that patients with breast-related diseases make appointments with thoracic surgery clinics rather than general surgery clinics.

In our study, thoracic surgery outpatient clinic appointments were reviewed retrospectively. Patients who scheduled incorrect appointments, patients who missed their appointments, and the demographic data of these patients were examined. Our aim was to ascertain information about the possible causes of problems in the current appointment system and to procure solutions to these problems. In addition, we also discussed potential measures that could be taken to solve such problems.

Materials and Methods

Approval 2022 / 92 was obtained from our hospital ethics committee for the study. The data of patients who made an appointment with the thoracic surgery outpatient clinic through CPAS between January 1, 2021 and December 31, 2021 were analyzed retrospectively. Patients who applied to our outpatient clinic with a complaint related to a clinic than thoracic surgery were grouped as patients with incorrect appointments (PWIA). The study did not include follow-up appointments of patients who were previously evaluated, underwent surgery, or followed up by our clinic. Records of outpatient consultations, patients without an appointment, and patients scheduled for elective surgery were also not included. Demographic data such as age, sex, appointment time and the presenting complaints of the patients were recorded daily. At the end of each outpatient service day, all outpatient records were examined and recorded. Data were presented as percentages and mean.

Results

Among the 1482 patients who made an appointment via CPAS during the study period, 278 (18.8%) missed their scheduled appointment. Of these 278 patients, 166 (59.7%) were female and 112 (40.3%) were male, with a mean age of 41.5 ± 8.5 (range: 18-81) years for females and 44.1 ± 4.2 (range: 18-81) for males. With regard to scheduled appointment time, 175 (62.9%) patients missed morning appointments and 103 (37.1%) missed afternoon appointments. The patients most frequently missed the 09:00 and 11:00 appointments (20 patients each, 11.4%) in the morning, and the 15:50 (16 patients, 15.5%) and 14:00 (13 patients, 12.6%) appointments in the afternoon.

It was determined that 128 (8.6%) of the patients applied to our outpatient clinic with a complaint concerning a clinic other than thoracic surgery. Of these patients, 91 (71.1%) were female and 37 (28.9%) were male, with a mean age of 41.4 ± 15.5 (range: 16-80) for females and 49.2 ± 19.5 (range: 23-84) for males. Seventy-seven of these patients (55.5%) reported that they had mistakenly made an appointment with the thoracic surgery outpatient clinic instead of the chest diseases outpatient clinic. Twenty-eight of these patients (36.4%) made appointments for asthma, 23 (29.8%) for coronavirus disease-2019, 10 (12.9%) for chronic obstructive pulmonary disease (COPD), and 4 (5.2%) for other reasons such as pre-employment examination.

Thirty-eight (29.7%) of the patients with incorrect appointments made an appointment with thoracic surgery instead of general surgery. Thirty-seven (97.4%) of these patients were female and the most common complaints were palpable breast mass in 10 (26.3%) patients and breast pain in 10 (26.3%) patients. Other female patients also presented with breast complaints such as discharge (6 patients, 15.8%). The complaint of the only male patient who mistakenly applied to our clinic instead of general surgery was inguinal hernia.

Thirteen (10.2%) of the PWIA patients also applied to our outpatient clinic with complaints that fell under the authority of different clinics. The most common complaint in these patients was aesthetic complaints about the breast (asymmetry in 2 patients, size in 1 patient, etc.). Other patients had atypical complaints such as allergic rhinitis (1 patient) and back pain associated with herpes zoster infection (1 patient).

Discussion

In this study, we found that 278 (18.8%) of the patients who had scheduled an appointment missed their appointment, 128 (8.6%) were in the PWIA group, and 406 (27.4%) of 1482 appointments caused unnecessary workload in the thoracic surgery outpatient clinic.

Outpatient clinics are the first units where patients apply for the outpatient examination, testing, diagnosis, and treatment services [1,2]. Efforts are being made to improve and increase the standards of outpatient care, which constitutes an important part of healthcare. The CPAS, which allows outpatient clinic appointments to be organized and controlled through a centralized system, is one aspect of these efforts. CPAS has many advantages for patients, such as easier access to outpatient clinics, benefiting from outpatient care at their convenience, and being able to undergo examinations without queues. However, it is common for patients to miss their appointments. This causes unnecessary workforce loss and other patients who need outpatient care cannot schedule appointments. In the 2017 CPAS services report of the Ministry of Health of Turkey, it was reported that appointment compliance rate was 74.6% in Ankara, 76.5% in Istanbul, 79.3% in İzmir, and 75.6% throughout Turkey [4]. This rate was relatively higher in our study (81.2%). From this point of view, it can be concluded that thoracic surgery patients appear to have greater adherence to their appointments than the general patient population. Although the 2017 CPAS report includes appointment compliance rates by provinces and health centers, there is no data based on clinics. For this reason, we did not have the opportunity to compare the data of our outpatient clinic with other outpatient clinics. However, similar problems were experienced in other clinics, leading to the development of the “backup appointment” application [5].

Another important piece of information acquired in our study is the high number of patients who made an appointment with the incorrect clinic, despite the fact that they showed up for their appointments. Although this is a frequently encountered problem, not enough studies have been carried out on this subject. To solve this problem, it was aimed to direct patients towards correct outpatient clinics with modules integrated into CPAS, such as the “What do I have?” module. Another characteristic of this problem is that it differs from clinic

to clinic. It was not unexpected that the majority of patients who made an incorrect appointment with the thoracic surgery outpatient clinic were those who had to make an appointment with the chest diseases clinic. In addition, the fact that the clinics have similar names and that patients often have difficulty in acquiring appointments from the chest diseases outpatient clinic (due to the large number of patients seeking healthcare from this clinic) may also have played a role. More surprisingly, patients with breast-related complaints or diseases that are not closely related to the thoracic surgery clinic frequently scheduled appointments with the thoracic surgery clinic. In our study, the percentage of these patients was 2.5% in all patients with an appointment and 3.1% in patients who showed up for their appointments. Informing patients about this issue can prevent unnecessary appointments and patient grievance. Similar errors in appointment scheduling are also encountered in other outpatient clinics. For example, it is common in daily practice for patients to apply to Gynecology and Obstetrics clinics for breast-related complaints and to cardiovascular surgery clinics with cardiology-related complaints. Although the problem is frequently encountered, the literature on the subject is very limited and most of the studies in this field have focused on patient satisfaction rather than problems in outpatient care [6-9]. One of the rare studies addressing incorrect appointments was carried out by Akbaş et al [10], and the percentage of incorrect appointments was 3% in this study which enrolled 372 patients. This frequency was found to be much higher (8.6%) in our study. This difference can be explained by the high rate of admission of patients with breast-related complaints or disease. In a study by Kişioğlu et al [11], a much more striking result was obtained. It was found that 64.5% of the patients could have been treated in family medicine outpatient clinics and, in fact, they did not need to apply to any specialty outpatient clinic. In addition, the rate of scheduling an appointment from the specialty clinic was found to be 12.9%.

The limitations of our study are that it was a single-center study and contained data from only a 1-year period. Despite this limited study population, clear and remarkable results have been obtained. Although problems are frequently encountered in outpatient care, studies on this subject are insufficient and available in-

formation is very limited. We think that our study can be pioneer in this respect for other clinics and may guide them in the analysis and comparison of their own out-patient services.

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Authors' contribution

EK, ÖK; conceptualized and designed the study, collected and analyzed data and co-wrote the paper.

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Original Article

Abdominothoracic fistulas due to complicated Echinococcosis: surgical treatment and outcome

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ABSTRACT

Background: Abdominothoracic fistulas are severe complications of hydatid disease. We report here on the results of treatment of hydatid abdominothoracic fistulas in 17 patients.

Material and Methods: A single-center case series of 17 patients with abdominothoracic fistulas (ATF) was treated at our hospital from 2004 and 2019. Nine men and eight women patients (age range: 46-85 years; median age: 59 years) were treated for abdominothoracic fistulas (ATF). The main symptoms were dyspnea, chest pain, cough, purulent sputum, high fever in 15 patients and additionally biliptysis in two patients. Fistulas were hepatopleural (HPF) in 14, bronchobiliary (BBF) in two and abdominopleural in one patient.

Results: Fourteen patients were operated for HPF and 3 (18%) patients were treated with percutaneous transhepatic drainage and tube thoracostomy. All patients were discharged from the hospital in good health. Our strategy consisted of adequate evacuation of the intrahepatic cyst, closure of the fistula via thoracophrenotomy and long term drainage of the intrahepatic or subhepatic cyst space up to ceased biliary drainage.

Conclusions: ATF due to hydatid cyst is uncommon. In rare cases ATF may be present at the abdominal, thoracic or diaphragmatic level. Thoracophrenotomy is the best surgical treatment for all three levels. In unstable patients only long-term percutaneous drainage should be applied. Medical treatment with Albendazole is indicated when dissemination is confirmed. Early diagnosis and management of septic associated complications are main goal.

Keywords: abdominopleural fistula, complication, cyst hydatid

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Introduction

An abdominothoracic fistula (ATF) is defined as an abnormal communication between the abdomen and the bronchial tree or pleura due to trauma or hydatid or amoebic liver disease [1]. Although a rare entity, it is considered a severe complication of hydatid liver disease. A liver cyst may rupture into the biliary tree, a hollow organ, through the diaphragm into the pleural cavity, or directly into the peritoneal cavity [2,3]. Intrapulmonary rupture of a hepatic hydatid cyst is usually uncommon and the underlying cause is mostly due to the hepatic hydatid cyst perforation to the right subphrenic area and then fistulation into the posterior basal segment of the right lower lobe of the lung [4]. Management of these fistulas is often very difficult and can be associated with high morbidity. Surgical closure of the fistula tract with efficient drainage of the chest and cystic cavity is the first and the most common treatment approach [5]. There exists no clear consensus or guidelines for the management of life-threatening complications.

We report here on our practice of treating 17 patients with ATF.

Materials and Methods

We retrospectively reviewed the patient records of 17 patients with ATF due to hydatid disease who had been treated between 2004 and 2019. Written informed consent was obtained from all patients; patients attested that they understood their treatment options, potential complications, expected risks and possible benefits of treatment. The study was approved by the Institutional Ethics Committee (Reference No:TUTF-GOBAEK 2022/274). There were nine men and eight women, whose ages ranged between 46 and 85 years. A written informed consent was obtained from all patients. As a surgical approach, we performed drainage of the perforated cystic lesion via, thoracophrenotomy, preferring partial pericystectomy to liver resection because of the need to avoid the redundant loss of normal parenchyma. Cyst aspiration before removal was the essential method of treatment for intact cysts of liver. The purulent contents of the hepatic and pleural cavity were cleared, and it was irrigated intraoperatively with povidone-iodine or hypertonic saline used as scolicidal agents. The area of fibrous tissue and abscess on the diaphragm was debrided; the fistula tract was closed, and segment or lob of involved lung was resected (Figure 1A). A subdiaphragmatic drain

was placed in all patients undergoing thoracophrenotomy, and it was left in place for a few days or until the output bile drainage was minimal (which ranged from 5 days to 3 months) in patients with bile drainage. Endoscopic retrograde cholangiopancreatography (ERCP) had been carried out in two patients by the gastroenterologist for continued leakage of bile from PTHD before surgery for biliary decompression. Bile leakage decreased but did not stop after ERCP; therefore, both underwent surgical treatment. There was no need for biliary decompression (ERCP) postoperatively. Postoperatively, albendazole 800 mg/d was given to all patients during 3 months to prevent recurrence. The follow-up period included monthly biochemical tests for liver function and clinical examination in patients using albendazole. After discharge, radiologic examination was applied in the third and sixth months and in the first year with chest x-ray and thorax CT if required.

Results

The main symptoms were cough, dyspnea, chest pain and purulent sputum in 15 (88%) patients and biliptysis in two patients. Six patients underwent previous operation or intervention for liver hydatid disease. The patients with biliptysis had increased bile-stained expectoration that ranged from 100 and 500 mL/day in quantity. On physical examination, decreased breath sounds were found over the right basal lung areas in all patients, except one. The diagnostic work-up included biochemical tests for liver function, chest x-rays and computed tomography, which were applied routinely to detect hepatic and pulmonary cysts. A fistulous tract reaching to the basal segments of the right lung was shown with contrast injection through the catheter inserted under fluoroscopic guidance into the hepatic cystic cavity in the two patients with biliptysis (Figure 1B). Thorax computed tomography (CT) revealed right lower lobe pneumonia, pleural thickening or destroyed basal segments of the right lower lobe in 10 (59%) patients (Figure 2). Four patients were also cysts with concomitant liver and right lower lobe. Air-fluid level suggesting subdiaphragmatic abscess formation was also seen most of the patients. However, it was often difficult to demonstrate the fistula itself before surgery. In the sputum and pleural fluid analysis, viable scolices or membranes were revealed in 10 (59%) patients. The results of diagnostic evaluation demonstrated that fistulas were hepatopleural (HPF) in 14 (82%) patients, bronchobili-

ary (BBF) in two and abdominopleural (APF) in one. The predisposing pathology is summarized in Table 1. No scolical drugs were used preoperatively. Serological and skin testing for hydatid disease were not part of our routine diagnostic tests. Two patients with biliptysis were started on a diet including low fat. First, A percutaneous transhepatic drainage (PTHD) into the cyst cavity had been performed by interventional radiologists in six patients, and symptomatic healing of the abdominal symptoms but not of the biliptysis was observed. In three of these patients, only concomitant drainages of both PTHD and TT were performed, due to the patient's generally poor condition. In seven patients; tube thoracostomy (TT) was first performed because they were referred with pleural fluid accumulation. Surgical treatment is summarized in Table 2. Twelve patients underwent right thoracophrenotomy in the seventh or eighth intercostal space for the destruction of lung parenchyma due to biliary destruction, prolonged compression or infection. Right lower decortication was performed with video assisted thoracoscopic (VATS) in one patient. A left thoracophrenotomy was applied in one patient due to a parenchyma left lower lobe related to abdominopleural fistula. We performed lobectomy in two patients due to destroyed lobes and wedge resection in six patients for the damaged lung part. There was extensive evidence of the thickened pleura with empyema intraoperatively in four patients, and all of them underwent decortication. Cystotomy and capitonnage were performed for the cyst localized to the right lower lobe in four patients. All patients were discharged in good condition. There was no 30-day mortality in our series. The treatment algorithm we used in patients with ATF based upon the our experience is summarized in Figure 3.

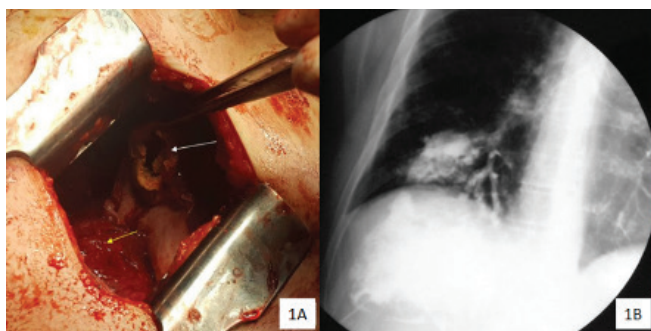


Figure 1. Peroperative view shows fistula tract in diaphragm (white arrow) and destroyed lung tissue (yellow arrow) (A), fistulogram revealed a broncho-biliary fistula on the liver between bronchial tree (B).



Figure 2. Computed tomography demonstrating consolidation of the lateral basal segment of the right lobe (A), boronal section computed tomography same patient showing a right subdiaphragmatic cystic cavity (B).



Figure 3. Algorithm for ruptured hydatid cyst in the thorax with biliobronchial fistula.

Discussion

Cyst hydatid disease remains a serious sanitary problem for the Middle East, Australia, New Zealand, and Mediterranean countries, including Turkey. Abdominothoracic fistula carries a high mortality risk of 10.3% according to the literature, mainly due to surgical complications [6]. Abdominal cyst hydatid rupture and erosion of the diaphragm lead to passage of the contents of the cyst through the diaphragm into the pleural space, parenchyma or bronchus, causing pneumonitis, empyema and bronchobiliary fistula (BBF). Abdominothoracic fistula can occur in several ways: hepatopleural (HPF), bronchobiliary (BBF) or abdominopleural fis-

Table 1. Patients' demographic data, including fistula type, pathology, and the presence of bile and scolices in body fluids.

No	Age	Sex	Fistula Type	Bile	Scolex	Pathology
1	62	F	APF	Ø	Ø	Cystic abscess in splenic zone
2	62	M	BBF	Sputum	Sputum	Liver and lung cyst
3	47	M	BBF	Sputum	Ø	Liver cystic abscess
4	59	M	HPF	Pleural fluid	Ø	Liver cyst
5	53	F	HPF	Ø	Pleural fluid	Liver cyst
6	60	F	HPF	Pleural fluid	Pleural fluid	Liver cyst
7	73	F	HPF	Pleural fluid	Pleural fluid	Liver and lung cyst
8	46	M	HPF	Pleural fluid	Pleural fluid	Liver and lung cyst
9	70	M	HPF	Pleural fluid	Pleural fluid	Liver cyst
10	54	F	HPF	Pleural fluid	Pleural fluid	Liver cyst
11	65	M	HPF	Pleural fluid	Pleural fluid	Liver cyst
12	52	F	HPF	Pleural fluid	Ø	Liver cystic abscess
13	56	F	HPF	Pleural fluid	Ø	Liver and lung cyst
14	58	M	HPF	Pleural fluid	Pleural fluid	Liver cyst
15	72	M	HPF	Pleural fluid	Ø	Liver cyst
16	29	F	HPF	Pleural fluid	Pleural fluid	Liver cyst
17	85	M	HPF	Ø	Ø	Liver cyst

Abbrev.: APF: abdominopleural fistula; BBF: bronchopleural fistula; HPF: hepatopleural fistula.

tula (APF). Clinical features and symptoms preceding the development of ATF can be distinctive according to fistula type. APF causes irritating cough, chest pain and pleural effusion and basilar atelectasis. HPF includes fever, chest pain, productive cough, right upper abdominal pain, presence of bile in the pleural fluid, sometimes jaundice. BBF characterized bile stained sputum, fever, findings of sepsis and poor general status [7,8] (Table 1). Unstable septic patients in admission need hemodynamic, respiratory and nutritional support, followed by as early as surgical intervention.

Diagnosis can be radiological or include interventional methods. Thorax CT can reveal hepatic cyst and abscess, and pleural effusion; however, it does not show fistula tract in most patients. If bile-stained sputum or pleural fluid or jaundice detected, a more precise examination is required. In this situation, magnetic resonance imaging (MRI) and MR cholangiography can be useful tools, although there are publications that suggest that it can also fail to indicate the fistulous tract [9]. If a fistula is suspected and there is jaundice, this may indicate the need for further investigation and treatment using ERCP or percutaneous transhepatic cholangiography (PTC) for fistula and possible distal biliary obstruction [10-12]. There had been continued leakage of bile whereupon ERCP had been applied by the gastroenterologist; in two patients with BBF, however, leakage continued. Upon this, we performed liver cystotomy with right thoracophrenotomy and subdiaphragmatic drain inserted; therefore, leakage ceased after 1 and 3 months in two patients. Some authors have indicated cases of spontaneously closure of the fistula after ERCP or PTC. Other authors have stated that the more con-

servative methods require a long-lasting drainage period as long as 5 weeks [6,13]. If chronic fistulas associated with thoracic and abdominal sepsis and respiratory impairment is present, surgery should be considered for such patients as the gold standard.

Table 2. Surgical treatment options for abdominothoracic fistulas.

No	First attempt	Surgery
1	Ø	Left lower lobectomy
2	PTHD+ERCP	Cystotomy, capitonage, Liver cystotomy
3	PTHD+ERCP	Liver cystotomy, tractotomy
4	TT	RLL decortication, Liver cystotomy
5	PTHD	TT
6	TT	RLL wedge, Liver cystotomy
7	TT	RLL wedge, Liver cystotomy
8	Ø	RLL wedge, Liver cystotomy
9	Ø	RLL lobectomy
10	PTHD	RLL wedge, Liver cystotomy
11	PTHD	TT
12	TT	VATS decortication
13	TT	RLL cystotomy, capitonage decortication, Liver cystotomy
14	Ø	RLL wedge, Liver cystotomy
15	TT	RLL wedge, Liver cystotomy
16	TT	RLL decortication, Liver cystotomy
17	PTHD	TT

Abbrev.: Endoscopic retrograde cholangiopancreatography (ERCP), PTHD: percutaneous transhepatic drainage; RLL: right lower lobe; TT: tube thoracostomy.

Once ATF develops, a cure is possible only with the removal of possible biliary obstruction, efficient drainage of any associated abscess and treatment of the underlying disease [1]. Drainage of pleural infection, excision or decortication of destroyed lung tissue and fistula tract through phrenotomy should be performed. Moreover, biloma, abscesses and any other pathology in the subdiaphragmatic area can be cleared and a long-lasting rubber drain can be inserted. Ferguson and Burford [14] reported that successful management of the fistula with immediately aggressive surgery thoracotomy, efficient subdiaphragmatic drainage using phrenotomy, careful closure of the diaphragmatic fistula tract with non-absorbable sutures, decortication of a thickened pleura. Standard thoracotomy has been offered as a better approach to BBF because it provides radical treatment of bronchopulmonary disease [15-17]. Tocci et al [18] claimed that standard thoracotomy was unsafe due to lack of control of the hepatic pedicle and access to the biliary tree; therefore, it may result in serious intraoperative risks. In their study, they recommended thoracoabdominal incision for good access to the hepatic pedicle and to the biliary tract to enable hemostatic maneuvers and any needed surgical intervention on the biliary tract if needed. The approach of an option in our patients was a right thoracotomy and phrenotomy through the seventh or eighth intercostal space, as this proposed good exposure to the subphrenic abscess and of the destroyed lung tissue. Radical surgical approaches (e.g., resection) were performed in case of destruction of the enclosing lung parenchyma or after cyst removal, re-expansion problem of atelectatic lung. Six wedge resections and two lobectomies were performed due to the destroyed or compressed lung parenchyma in our series. In four patients of empyema and due to thickened pleura, lung decortication was completed the surgical approach. In patients with coexisting abdominal cyst, thoracophrenotomy is the best procedure for surgical treatment at all three levels. As we mentioned earlier, according to previous publications, subcostal incision and thoracophrenotomy during one stage operation provided a larger surgical field above and below the diaphragm [5]. The most difficult step of the operation may be the repair of inflamed diaphragms. Large defects can be managed with mobilization of nearby tissue (pericardial fat, intercostal muscle, omentum) or synthetic mesh. However, in most cases, primary closure with non absorbable sutures to close the defect was

enough [6,19]. None of our patients required any other methods except primary suture.

There was no mortality and morbidity as a result of the one-stage operation. In case of the concomitant hepatic hydatid cyst below the diaphragm, removal of both liver and lung lesions during one stage operation is the best option. Rabiou et al [20] proposed that exclusive endoscopic sphincterotomy may be an alternative in some non-operable patients. In our two patients, bile leakage continued despite sphincterotomy PTHD. These patients were operated. Bile drainage was interrupted only with PTHD in three of our patients who were not suitable for the operation. We believe that medical treatment after surgery is required for a ruptured intrathoracic hepatic hydatid cyst, when there is dissemination or when total evacuation of the cyst is impossible. We recommend albendazole 400 mg twice daily for 3 to 6 months in such patients. Kuzucu et al [21] also recommended daily treatment with albendazole 800 mg for at least 2 months after surgery for all patients with multiple hydatid or complicated cysts or both.

In conclusion, although the frequency of cyst hydatid disease has decreased, rupture of hydatid cysts to the bronchial tree and pleura still remained as a severe complication that can lead to high morbidity and mortality. Careful evaluation and early surgical treatment without delay and before the development of septic complications are the main requirements. We believe that the thoracophrenotomy procedure is a good and safe choice of surgical treatment at all three levels. The patients with poor general condition, only long-lasting percutaneous drainage should be performed. Medical treatment with albendazole is recommended when dissemination is approved. This study is a retrospective non-randomized small sized patient population and single center study. However, further long-term studies including more patients and longer follow-up intervals are required

Declaration of conflicting interests

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Ethics approval

The study was approved by the Institutional Ethics Committee (Reference No:TUTF-GOBAEK 2022/274).

Authors' contribution

YAK: conceptualization, methodology, design of the work, formal analysis, acquisition writing-orginal draft
 FY: investigation, data curation, YY: supervision.

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Case Report

Esophageal perforation, aortic pseudoaneurysm and aorto-oesophageal fistula caused by ingestion of a chicken bone

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ABSTRACT

Esophageal foreign bodies are an emergency entity. Rarely, it can cause fatal complications such as aorto-oesophageal fistula. In this study, the authors present a case of esophageal perforation, aortic pseudoaneurysm, and aorto-oesophageal fistula in an adult male patient after chicken bone ingestion, resulting in a poor outcome. An urgent and multidisciplinary approach is very critical in the diagnosis, treatment, and clinical management of aorto-oesophageal fistula.

Keywords: aorto-oesophageal fistula, aortic pseudoaneurysm, chicken bone, esophageal perforation, foreign body

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Introduction

Foreign body ingestion is one of the most common reasons for admission to emergency departments. The majority of foreign bodies pass through the gastrointestinal tract without causing any complications or sequelae [1]. However, foreign bodies can cause fatal complications in the gastrointestinal tract.

Here, we present the imaging findings and clinical features of a 56-year-old male patient with esophageal perforation, aortic pseudoaneurysm, and aorto-oesophageal fistula, which are rare complications of foreign body ingestion.

Case Report

A 66-year-old male patient was admitted to an external clinic with odynophagia that started after eating chicken. The patient was discharged with symptomatic treatment. Four days later, the patient presented to the emergency department with hematemesis and retrosternal pain. Her general condition was good and her hemodynamics was stable. Posteroanterior chest x-ray features were unremarkable to explain the symptoms. A contrast-enhanced computed tomography examination was performed. In the CT images, a linear-shaped hyperdense foreign body with a horizontal extension of 3 cm in the mid esophageal location at the level of the carina was seen (Figure 1). The esophagus was thickened at this level. The foreign body had penetrated the subcarinal area anteriorly and the thoracic aorta posteriorly. In addition, loss of integrity in the wall of the thoracic aorta at the penetration level and a pseudoaneurysm with a diameter of 7 mm was observed. No extravasation of the contrast agent was observed. Left pleural effusion was also seen (Figure 2). Emergency oesophagoscopy showed injury localization due to foreign body ingestion (Figure 3). The patient was operated on with a preliminary diagnosis of penetrating esophageal injury due to foreign body ingestion, and aorto-oesophageal fistula. After thoracotomy was performed through the 6th intercostal space, the mediastinal pleura was opened. The mediastinal hematoma was observed. A bone-shaped foreign body extending beyond the esophagus was seen above the carina level (Figure 4). Active bleeding from the thoracic aorta started following the removal of the foreign body. After manual compression, the aorta was sutured with mattress sutures of 4-0 polypropylene placed over teflon felt pledgets. The bleeding has been

stopped. Subsequently, the esophagus was sutured with a double layer of interrupted absorbable suture (mucosal and muscular planes) and reinforced of the suture by a pleural flap. Esophageal leakage was checked with methylene blue and none was detected. On the second day in the intensive care unit, the patient was urgently re-operated due to hemorrhagic contents coming from the thorax tube and a decrease in hemoglobin levels. Emergency thoracotomy was performed via the anterior 4th intercostal space and sutures were replaced over the old suture line after aortic cross-clamp. Bleeding was controlled. The patient was followed up in the intensive care unit under broad-spectrum antibiotic therapy. One day after the second operation, the patient developed respiratory failure and then died.

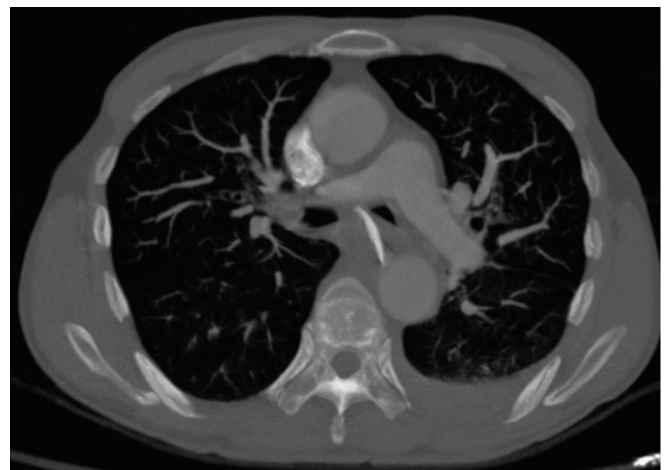


Figure 1. Axial maximum intensity projection computed tomography images show the extension of the foreign body from the subcarinal area to the aortic wall.

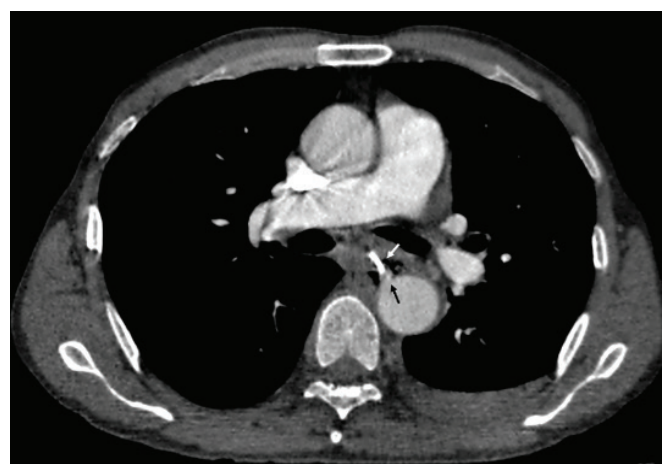


Figure 2. Axial contrast computed tomography shows hyperdense foreign body in the esophageal lumen (white arrow) and small pseudoaneurysm of the descending aorta (black arrow).



Figure 3. Penetrating injury localization due to foreign body ingestion was detected in oesophagoscopy.



Figure 4. Postinterventional image of the foreign body.

Discussion

Fish and chicken bones are the most common foreign bodies located in the esophagus [2]. Hemothorax, pneumothorax, pneumomediastinum, mediastinitis, soft tissue emphysema, cardiac tamponade, and aorto-oesophageal fistula are among the complications that can be seen due to foreign body digestion in the upper gastrointestinal tract [3]. The incidence of esophageal perforation due to foreign body ingestion has been reported as 1-4% [4]. Aorto-oesophageal fistula is a rare complication of foreign body ingestion. In the series of 2394 cases by Nandi et al, aorto-oesophageal fistula was reported at a rate of 0.08% [2]. The treatment of aorto-oesophageal fistula is complex and controversial. The operative option for each case is generated based on the patient's performance status and infection severity. The classical managements of aortoesophageal fistula were surgical correction with aortic cross clamping and cardiopulmonary bypass, simultaneous resection and repair of the thoracic oesophagus (although open repair has a 45–55% mortality rate), thoracic endovascular aortic repair (TEVAR) alone, and combined repair with TEVAR and open surgery [5]. Aortic suture or patch angioplasty can only be used for small lesions with cross-clamping. For larger lesions, aortic resection

must be applied into the well tissue. Aortic replacement is usually needed, particularly in cases with postoperative aortoesophageal fistula [6]. But both TEVAR and aortic replacement carry the risk of prosthetic and aortic stump infection, which can occur even as a long-term complication in an infective environment.

In conclusion, oesophageal foreign bodies are an emergency entity. Radiological imaging examinations play a critical role in diagnosis, especially contrast-enhanced computed tomography. An urgent and multidisciplinary approach is crucial in diagnosis, treatment, and clinical management. Delay in diagnosis and treatment increases the mortality rate [5].

Declaration of conflicting interests

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Authors' contributions

CO; investigation, writing- reviewing and editing, YAK; resources, investigation, data curation, NT; supervision, project administration.

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Case Report

Six different types of primary tumors in a lady: multiple primary tumors

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ABSTRACT

Multiple primary tumors are the ones that develop in the same patient at the same or different times. Each separate tumor should be proved to be malignant by histologic examination to rule out metastatic disease. A 59 year-old female patient was referred to our clinic for a newly diagnosed solitary pulmonary nodule. She is an uncommon case who has six primary tumors; a Kaposi's sarcoma of extremity, an infiltrative ductal carcinoma of breast and four different types of lung neoplasms.

Keywords: adenocarcinoma in-situ, carcinoid tumor, infiltrative ductal carcinoma, Kaposi's sarcoma

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Introduction

The term, multiple primary tumors (MPT) is used for the tumors which occur in a patient simultaneously or in different time periods. They account 0.7%–11% of all carcinomas. Four or more neoplasm occur in <0.1% of MPT cases [1,2]. It is known that the subsequent tumor develops as a result of many different interactions and also presence of a tumor increases the risk of developing another one [1,3]. In this report we present a 59 years-old lady with an uncommon case who has six primary tumors.

Case Report

A 59 years-old nonsmoker lady followed by an oncologist for a breast cancer history and was referred to our clinic for a newly diagnosed solitary pulmonary nodule. Her detailed medical history revealed a Kaposi's sarcoma of 1cm that was raised on the second finger of the right foot and was treated with radiation therapy 34 years ago when she was 25 years old. In 2014, a mass had arisen in her left breast, a tru-cut biopsy was performed and diagnosed as infiltrative ductal carcinoma. She had underwent left lumpectomy and axillary lymph node dissection. The final pathologic evaluation revealed a stage 2B tumor (T2N1M0) and combined six cycles of adjuvant chemotherapy and radiation therapy was performed. There were no signs of BRCA-1 and BRCA-2 mutations in blood test. Just after, hormone therapy was decided to be used for five years. But in the third year of her routine follow up, a pulmonary nodule was detected on chest x-ray, and thorax computed tomography revealed a 1 cm sized solitary pulmonary nodule on left upper zone. A PET-CT scan was performed and a ground glass opacity which was 11mm on left apicoposterior segment with a SUVmax value of 4.2 was detected. For preoperative evaluation a flexible bronchoscopy was made and the left bronchial tree was observed to be normal while surprisingly the right middle lobe medial segment bronchus was found to be fully obliterated with an endobronchial lesion. Multiple biopsies were made from the lesion and the pathologic evaluation revealed a carcinoid tumor. Videothoracoscopic wedge resection of the left apical lesion was performed. However, the frozen section was not able to differentiate a metastatic or primary lesion so the operation was terminated and final pathology revealed

a primary lung adenocarcinoma in situ. In another session a right sided videothoracoscopic middle lobectomy was performed for the carcinoid tumor and the final pathology revealed a 7mm in-size typical carcinoid tumor with reactive 8,9,10 and 11th station mediastinal lymph nodes. And finally a third operation, a left posterolateral thoracotomy was performed to complete the left upper lobectomy, Pathologic examination revealed another focus 11mm in size in the remaining upper lobe which was diagnosed as nonmucinous adenocarcinoma in situ. Also another palpable 6 mm in-size lesion was found in the left lower lobe and it was also resected, unfortunately the latter lesion was also diagnosed an adenocarcinoma in-situ. So the final pathologic diagnosis for all the four lung tumors respectively were a stage 1A typical carcinoid tumor, adenocarcinoma in-situ, nonmucinous adenocarcinoma in-situ, acinar predominant type adenocarcinoma. Immunohistochemistry confirmed the diagnosis primary pulmonary carcinoid tumor, tumor cells were positive (+) for synaptophysin and chromogranin. Presence of the three different types of lung adenocarcinoma was decided by comparative histopathologic examination. Immunohistochemistry confirmed the diagnosis primary pulmonary acinar predominant type adenocarcinoma; tumor cells were positive (+) for Napsin A and thyroid transcription factor-1 (TTF1) while negative (–) for GCDFP15, mammoglobin. The other focus diagnosed as primary pulmonary nonmucinous adenocarcinoma in-situ was also confirmed by immunohistochemistry; tumor cells were positive (+) for napsin A, TTF1 and surfactant A while negative (–) for mucin. For the third focus diagnosed as primary pulmonary adenocarcinoma in-situ, immunohistochemistry revealed the tumor cells were positive (+) for napsin A and cytokeratin (CK) 7 (Figures 1a-c). (Table 1). DNA isolated from the paraffin blocks obtained from the left upper lobectomy specimen revealed a p.L858R (C.2573T>G) point mutation located on exon number 21 and codon number 858 of the EGFR gene. There was no mutation on ALK and ROS1 gene. With the decision of a multidisciplinary council adjuvant targeted chemotherapy was planned, the patient was discharged uneventfully and there is no signs of a disease in the 9th months of the follow-up. Written informed consent was obtained from the patient for the publication of her data.

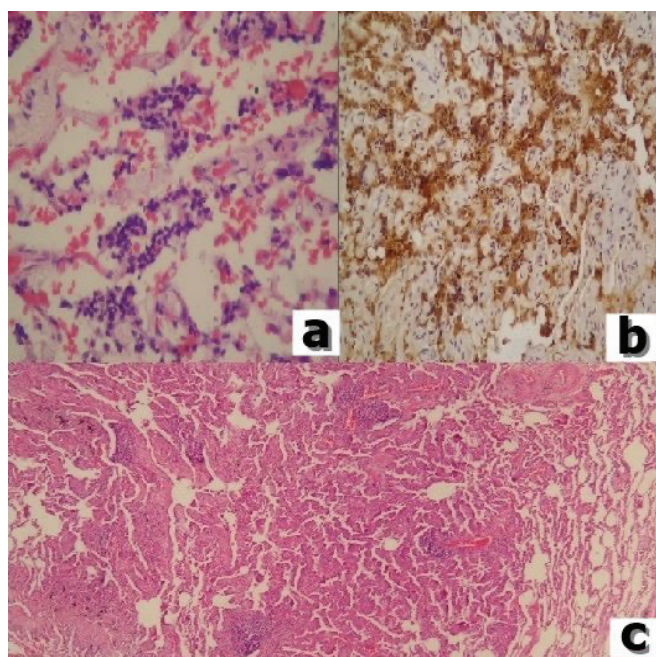


Figure 1. Presence of the three different types of lung adenocarcinoma was decided by comparative histopathologic examination. acinar predominant type (a), nonmucinous adenocarcinoma in-situ (b), adenocarcinoma in-situ (c).

Table1. Clinico-pathologic characteristics of the patient.

Age	Organ	Treatment	Histology / TNM stage
25	Right foot 2nd finger	RT	Kaposi's sarcoma (T1N0M0) stage 1A
55	Left breast	Surgery- adjuvant chemotherapy, RT, hormonotherapy	Invasive ductal carcinoma (T2N1M0) stage 2B
59	Right lung middle lobe	Surgery	Typical carcinoid tumor (T1N0M0) stage 1A
59	Left lung lower lobe	Surgery- adjuvant targeted chemotherapy	Acinar predominant type adenocarcinoma (T1N0M0) stage 1A
59	Left lung lower lobe	Surgery	Nonmucinous adenocarcinoma in situ (T1N0M0) stage 1A
59	Left lung lower lobe	Surgery	Adenocarcinoma in situ (T1N0M0) stage 1A

Discussion

Some factors like new treatment options, increasing use of cytotoxic agents and ionized radiation have lead an increase in MPT prevalence [1,3-6].

The incidence of secondary tumors may also rise with the increase in the number of cancer patients in the following years. Therefore, extreme caution is required regarding the development of secondary tumors in the patients who are followed up and treated for primary tumors. Our case also has the history of a local radiation therapy for the Kaposi's sarcoma and chemotherapy combined with radiation and hormone therapy for an invasive ductal carcinoma of breast. These risk factors also must be considered in the developing of new primary tumors. On the other hand genetic predisposition is blamed in etiology. The patient reported here had no family members with breast cancer and the patient herself had multiple cases of breast and lung cancer (a typical carcinoid tumor, synchronous lung adenocarcinoma, and an infiltrative ductal carcinoma), no mutations in the BRCA1 or BRCA2 genes were found in her blood sample. DNA isolated from the paraffin blocks obtained from the left upper lobectomy specimen revealed a point mutation on EGRFR gene, while there was no mutation on both ALK and ROS1 genes. These results guided treatment of the patient.

Considering the aforementioned criteria, we can say that our case has six MPTs which are a Kaposi sarcoma of skin, an invasive ductal carcinoma of breast, a typical carcinoid tumor and the last three different types of lung adenocarcinoma.

In clinic approach, when two different types of histology are diagnosed in synchronous lung tumors, the term “multiple primary lung carcinoma (MPLC)” is used. Practically, to say that it is a multiple primary lung carcinoma, mediastinal lymph nodes must be free of disease and there must be no distant metastasis. The left upper zone tumors and the lower lobe tumor were each had pathology of different types. In our case, four lung lesions with two different histopathologic types made the MPLC diagnosis a challenging one.

When a MPLC is diagnosed, if respiratory functions and technical aspects allow multiple lung resections, surgical treatment is advised without any waste of time. After a current diagnose is achieved each lesion is staged separately. If one of them is exceeded stage 2 disease, surgery is not recommended. For bilateral disease, generally wedge resection and segmentectomy

is the choice while surgical resections including even pneumonectomy are the choice for unilateral disease [7]. In our case, a video-assisted right middle lobectomy for the typical carcinoid and an open left upper lobectomy and lower lobe wedge resection for the (6 mm) millimetric lesion were performed in two separate sessions. Systematic mediastinal lymph node dissection was also performed in both operations.

The five-year survival of patients with synchronous tumors is lower than the ones with metachronous tumors. An article by Markel et al comparing surgically resected synchronous lung cancers with single lung cancers has reported that nearly half of the (51%) synchronous tumors are bilateral and five-year survival is 23% for early stages [8]. In another report questioning the location of the tumor for being in the same or different lobe and also studying the histopathologic type, for surgically resected synchronous tumors, best five year survival is 33% for the ones in the same lobe with the same histopathology while the worst survival is 18% for the tumors in different lobe with different histopathology [9]. So the differentiation of synchronous MPLC and the metastatic disease is important. It has proven that long-term survival of surgically resected MPLC is better than Stage 3B and stage 4 diseases. Thus it is thought that surgical resection; especially an aggressive surgical approach is an important choice of treatment to achieve long-term survival for these patients [10,11].

In conclusion, patients with MPTs are always under risk of new primary tumors. In the presence of multiple tumors in bilateral lung always synchronous MPLC must be considered and biopsy should be performed for each of the lesions. Although survival of these patients is poor than the patients with similar stage primer lung carcinoma, aggressive surgical treatment should be a choice in selected patients.

Declaration of conflicting interests

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Authors' contributions

Fİ,İT,FD,ŞMD,GF: conceived and designed the current case report, co-wrote the paper, collected the clinical data. The authors discussed the case under the literature data together and constituted the final manuscript.

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Case Report

A case of tracheal adenoid cystic carcinoma treated with carinal resection and adjuvant radiotherapy

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ABSTRACT

Adenoid cystic carcinoma originates from the glands in the tracheobronchial mucosa and its primary treatment is complete surgical resection.

A 43-year-old male patient presented to our clinic with the complaints of cough, phlegm and haemoptysis continuing for the last 2 years. In his physical examination, a decrease in breath sounds was found in his left hemithorax during auscultation. As chest x-ray showed a left hilar enlargement, a thoracic computed tomography was taken which revealed a mass 17x21 mm in size extending from the lateral side of the lower left tracheal wall into the left main bronchus, considerably constricting the lumen. A biopsy was taken from the lesion during fiberoptic bronchoscopy and its histopathologic examination led to the diagnosis of Adenoid cystic carcinoma.

The patient was operated under general anaesthesia using right posterolateral thoracotomy which involved carinal resection and anastomosis of the distal side of the trachea with the right main bronchus end-to-end, and of the right intermediary bronchus with the left main bronchus end-to-side. Since surgical margin positivity was found in histopathologic examination, he was prescribed adjuvant radiotherapy. The patient is still asymptomatic after a 2-year follow-up.

Although negative surgical margins may not be achieved in locally advanced adenoid cystic carcinoma, resection of the tumor through complex surgical procedures with the addition of adjuvant radiotherapy enables long term survival.

Keywords: adenoid cystic carcinoma, trachea, surgery, radiotherapy

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Introduction

Adenoid cystic carcinoma (ACC) is a rarely seen salivary gland-like primary malignant neoplasm of the respiratory system and comprises approximately 0.2-0.04% of all primary lung cancers [1,2]. The primary treatment in ACC is surgical resection. Radiotherapy is used for adjuvant, definitive or palliative treatment purposes [3].

Case Report

A 43-year-old male patient presented to our clinic with the complaints of cough, phlegm and haemoptysis continuing for the last 2 years. There were no peculiarities in the patient's anamnesis other than having received medical treatment for bronchial asthma for 1.5 years. In his physical examination, a decrease in breath sounds was found in his left hemithorax during auscultation. As his posteroanterior chest x-ray showed a left hilar enlargement, a thoracic computed tomography was taken which revealed a lesion 17x21 mm in size extending from the lateral side of the lower left tracheal wall into the left main bronchus, considerably constricting the lumen (Figure 1). Thoracic magnetic resonance imaging revealed a soft tissue lesion approximately 13x16x25 mm in size with a slightly rough surface, which is localized at the level of the carina and extending to the trachea and left main bronchus in soft tissue intensity at T1 and hyperintense at T2, causing considerable constriction in the left main bronchus, and contrasted homogeneously after contrast (Figure 2). In fiberoptic bronchoscopy, an endobronchial mass was seen and a biopsy was taken. The patient was diagnosed with ACC after histopathologic examination and his PET-CT scan was taken for staging. In PET-CT, the lesion had SUVmax: 3.3 and no involvement was found in any other region (Figure 3).

The patient was operated using right posterolateral thoracotomy under general anaesthesia. After exploration, carinal resection and anastomosis of the distal end of the trachea with the right main bronchus end-to-end using 2.0 polyglactin, and of the right intermediary bronchus with the left main bronchus end-to-side using 3.0 polyglactin were performed (Figure 4). The patient was discharged at day 4 without any complications, but a histopathological examination of his surgical specimen showed surgical margin positivity. The patient was started adjuvant radiotherapy (RT) at postoperative week 4 and was administered 40 Gy RT at fractions of 2.0 Gy daily, 5 days a week

for 20 days in total. At the end of a 2-year follow up, the patient was asymptomatic clinically, radiologically and bronchoscopically with no recurrence.

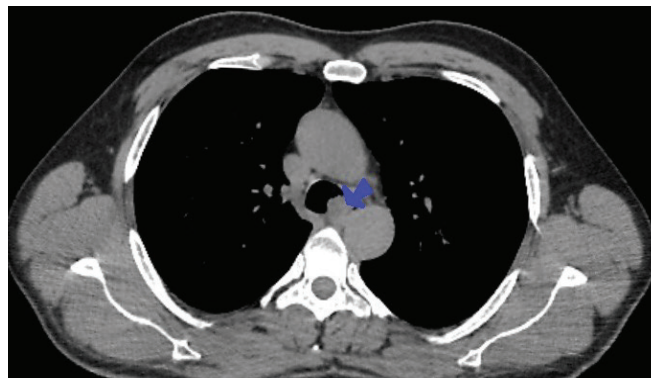


Figure 1. Lesion localized at the lower left lateral wall of the trachea, constricting the lumen as seen in the transverse section image of thoracic computed tomography (blue arrow).

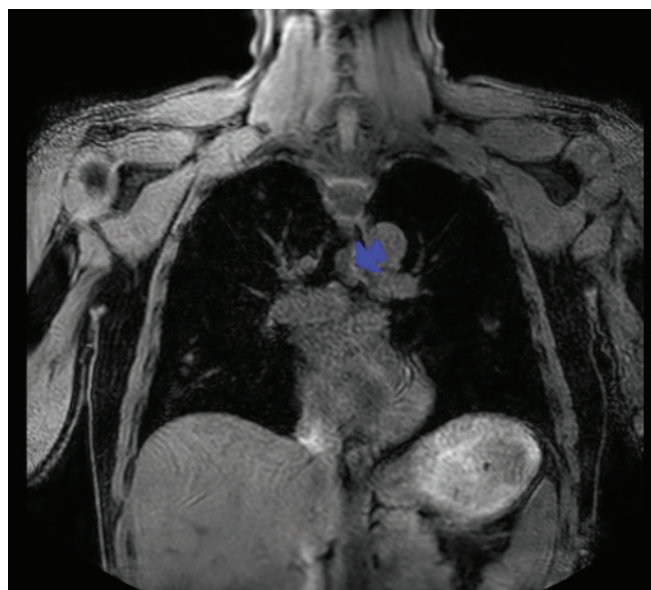


Figure 2. Soft tissue lesion with a slightly rough surface localized at the level of the carina, extending to the trachea and left main bronchus, in soft tissue intensity at T1 and hyperintense at T2 as seen in the frontal section of thoracic magnetic resonance imaging (blue arrow).

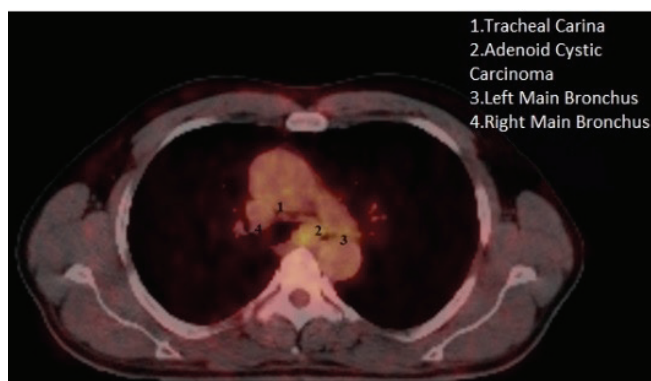


Figure 3. Lesion localized at the lower left part of the trachea and involving FDG as seen in PET-CT fusion images.

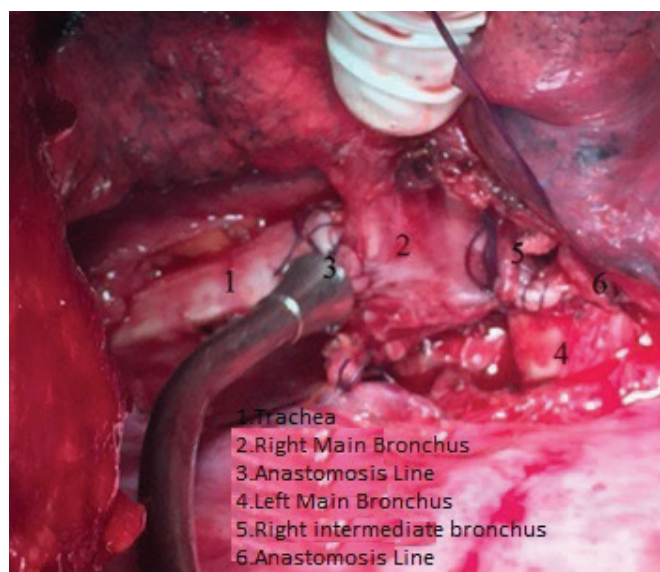


Figure 4. Anastomoses in completed form of the distal trachea and right main bronchus, and the right intermediary bronchus and left main bronchus after carinal resection as seen in the peroperative images of the patient.

Discussion

ACC is one of the rare lung tumors mostly seen around the age of 50 at equal proportions in both genders [4]. There were 2 (0.4%) ACC cases in the 515 lung cancer patients surgically treated in our clinic in the last 5 years and this data is consistent with the literature data.

In the respiratory system, 2/3 of ACC cases occur in the trachea and 1/3 in the main bronchi and distal airways. ACC is a slowly growing tumor, and depending on the mass covering the respiratory tract, symptoms such as cough, dyspnea, stridor and hemoptysis may be seen [4]. Most of these patients usually receive long-term medical treatment for the misdiagnoses of bronchial asthma or Chronic obstructive pulmonary disease. The growth in the size of the mass during this period results in worsening of the symptoms and clinical signs and leads to a misperception in the patient and physicians involved in the treatment that the disease does not respond to medical treatment. Our patient has also received medical treatment for bronchial asthma for a long time. Since his complaints persisted with the addition of hemoptysis to them in the last few months, a thoracic computed tomography was taken from the patient, which revealed a mass considerably constricting the tracheal lumen.

As ACC is a centrally localized, locally aggressive tumor and exhibits submucosal growth and perineural

infiltration, the possibility of its effective treatment is quite low. A complete surgical resection whenever possible is the gold standard of treatment in these patients [3]. However, it is often difficult to achieve negative surgical margins due to the submucosal growth tendency of the tumor. Positive resection margins after surgery are seen at a rate ranging between 8-82% in the literature [3]. Since the tumor extended from the lower left lateral wall of the trachea into the left main bronchus in our case, a complex surgery was performed during the same session, which involved carinal resection, anastomosis of the distal end of the trachea with the right main bronchus, and anastomosis of the right intermediary bronchus with the left main bronchus. Despite such a wide resection, tumor was found at the surgical margin and the patient was given RT. Surgical margin positivity is an expected problem in ACC and postoperative adjuvant RT is currently recommended to sterilize the microscopic tumors at the region. With RT, local control can be achieved and long disease-free survival and overall survival can be accomplished [2,4]. No recurrence after RT was seen in our patient during the 2-year follow-up. Although ACC is known to be a slow growing tumor with low malignancy and rare regional lymph node involvement, local recurrence and distant metastasis to the lungs, bones and brain at even very late periods may occur as part of unpredictable clinical course in these patients [5]. Therefore, long-term careful follow-up is a must in all such patients including ours.

In conclusion, although negative surgical margins may not be achieved in ACC cases, resection of the tumor through complex surgical procedures and the addition of adjuvant RT will enable obtaining pleasing outcomes with long term survival rates.

Declaration of conflicting interests

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

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Authors' contributions

ME,OT,SK,AA,CT: conceived and designed the current case report, co-wrote the paper, collected the clinical data. The authors discussed the case under the literature data together and constituted the final manuscript.

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