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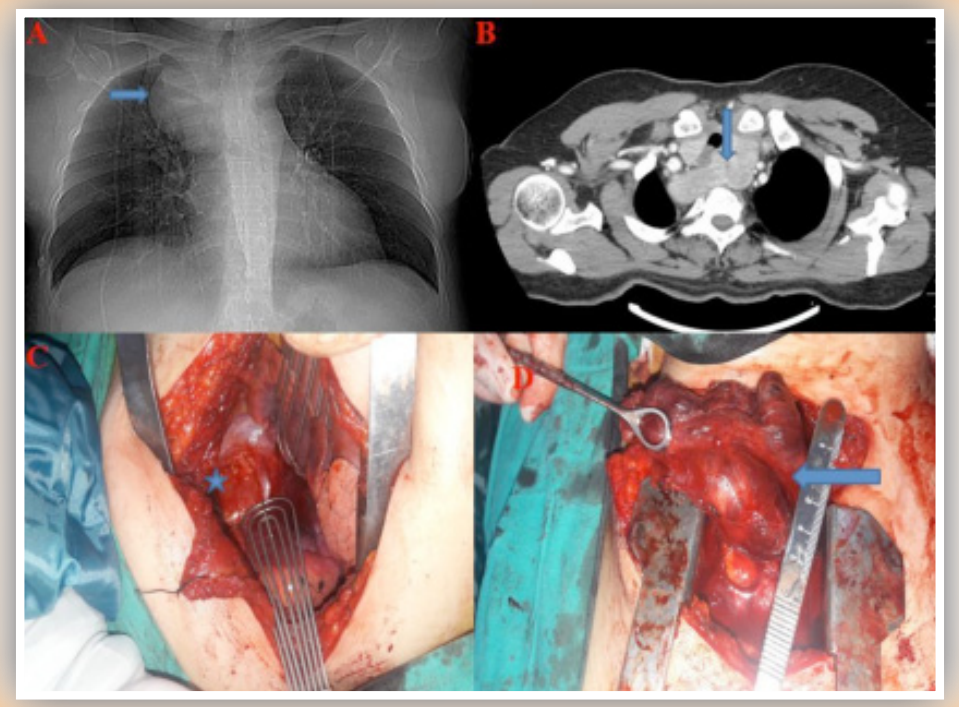

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The Current Thoracic Surgery is a current periodical, peer-reviewed and open access e-journal. It is the official e-journal of the Turkish Society of Thoracic Surgery and published three times annually.

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Original Articles

Case Reports

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Original Article

Cost analysis and evaluation of risk factors for postoperative pneumonia after thoracic and cardiovascular surgery: a single-center study

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ABSTRACT

Background: Postoperative pneumonia increases costs associated with inpatient stay, treatment, laboratory testing, and imaging, thereby increasing total healthcare costs. The aim of this study was to determine risk factors in patients who develop pneumonia after thoracic and cardiovascular surgery, evaluate relationships between these risk factors and cost, and conduct a cost analysis of postoperative pneumonia.

Materials and Methods: 111 patients who underwent major thoracic or cardiovascular surgery between June 2009 and March 2014 were evaluated retrospectively. Patients who developed postoperative pneumonia (p = 37) were compared with those who had no postoperative complications (p = 74).

Results: 40 men and 71 women were included in the study. Mean length of hospital stay was 21 days for patients with pneumonia versus 10 days for patients without pneumonia ($p < 0.001$). Significant risk factors for postoperative pneumonia were Charlson Comorbidity Index > 2, steroid use, high ASA score, presence of nasogastric tube, peripheral/central venous catheterization, postoperative heart failure/acute kidney failure, total parenteral nutrition, late postoperative mobilization, and prolonged ventilation and intubation ($p < 0.05$). Postoperative pneumonia was associated with significantly higher mortality rate and total cost ($p < 0.001$ for both). The mean cost of treatment for patients with and without postoperative pneumonia was 8211.7 TL and 3917.5 TL, respectively ($p < 0.001$). There were statistically significant differences between the two groups in the costs of surgery, radiology, antibiotics, and cultures ($p < 0.001$ for all). Correlation analysis between risk factors and cost revealed that prolonged intubation, late mobilization, and lack of respiratory rehabilitation exercises were associated with higher costs ($p < 0.05$).

Conclusions: Postoperative pneumonia significantly increases costs. Identifying and mitigating these factors will reduce both the incidence of infection and the associated costs. Because infection control measures help avoid infection and thereby infection-related costs, it is critically important to support infection control activities and prevent nosocomial infections.

Key Words: cost analysis, pneumonia, prognostic factors

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Introduction

Nosocomial infections are difficult to treat due to both patient characteristics and resistance in the infectious agents. In addition to increasing length of hospital stay and mortality rates, nosocomial infections create a substantial economic burden due to increased costs. The results of the Study on the Efficacy of Nosocomial Infection Control (SENIC) conducted in the mid-1970's provided a large database on this subject. This report, which was published in 1992 and included data on direct annual medical costs, brought attention to healthcare-associated infections and the significance of costs associated with them [1].

Although preventive measures have improved along with other medical advances, nosocomial pneumonia is an important problem in Turkey. There is not enough study on this subject in Turkish literature. There have been very few studies conducted in Turkey on the development and costs of postoperative pneumonia in particular. There are not enough studies in the literature on the risk factors and costs associated with pneumonia after cardiothoracic surgery, which accounts for a substantial proportion of postoperative pneumonias.

The present study evaluated risk factors for the development of pneumonia after cardiothoracic surgery and the relationships between these factors and cost.

Materials and Methods

A total of 111 patients who were diagnosed with pneumonia after undergoing a major operation in the thoracic and cardiovascular surgery department between 01 July 2009 and 31 March 2014 were evaluated retrospectively. Thirty-seven patients who developed pneumonia were compared with 74 patients with no additional complications during treatment. Thirty-six (32.4%) of the patients had pneumonectomy due to non-small cell lung carcinoma in the thoracic surgery department and 75 patients (67.6%) underwent coronary artery bypass and valve surgeries in the cardiovascular surgery department. Pneumonia was diagnosed based on the criteria for ventilator-associated pneumonia (VAP) published by the Centers for Disease Control and Prevention (CDC) [2]. The study was approved by the institutional review board and conducted in accordance with the principles of the Declaration of Helsinki.

Microbiological Examination

For mechanical ventilation in intensive care units (ICUs), secretions are removed using a closed system. Endotracheal aspirate sampling was done by disconnecting patients from the respirator and collecting a deep tracheal aspirate sample using a special cannula with a sterile reservoir. For patients who underwent bronchoscopy, bronchoalveolar lavage and protected specimen brush samples were analyzed. Sputum culture was obtained from patients who were not intubated. Bacteria were identified using conventional methods as well as BBL Crystal Enteric/Nonfermenter ID Kit and BBL Crystal Gram-Positive ID Kit (Becton & Dickinson, USA) systems.

Antibiotic susceptibility of the isolates was assessed using the Kirby-Bauer diffusion method according to Clinical and Laboratory Standards Institute (CLSI) standards. Antimicrobial agents were selected for antibiotic susceptibility testing based on CLSI recommendations. For resistant microorganisms, sensitivity to tigecycline and sulbactam-cefoperazone, which are not included in the CLSI recommendations, was evaluated based on EUCAST and literature data.

Comorbidities were evaluated using the Charlson Comorbidity Index (CCI). The patients' demographic characteristics and risk factors were gathered by retrospectively evaluating routinely collected data from the hospital records system. Postoperative complications and mortality was defined as deaths and complications that occurred within the first 30 days after surgery or after hospital admission.

We evaluated treatment-related expenses in terms of surgery, laboratory, radiography, antibiotic, culture, and inpatient stay costs, and analyzed correlations between postoperative pneumonia and these costs.

Statistical Analysis

Numerical variables were evaluated using mean and standard deviation or median (minimum-maximum) and categorical variables using number and percentage. Comparisons of numerical data between groups was done using independent samples t-test when parametric assumptions were met and the Mann-Whitney U test when these assumptions were not met. Kruskal-Wallis test was used in comparisons of multiple groups. Chi-square test or Fisher's exact test was used to determine whether the categorical variables differed between groups. Associations between numerical variables were analyzed using Spearman's correlation coefficient. All analyses were done using SPSS (version 22, SPSS Inc., Chicago, IL, USA) package software. Level of significance was accepted as $p < 0.05$.

Results

There were 40 women (36%) and 71 (63.9%) men in the study. Mean length of hospital stay was 11 days. Further analysis showed that mean length of stay was 21 days (min = 4, max = 55 days) for patients with pneumonia versus 10 days for patients without pneumonia ($p < 0.001$). Distributions of the patients' demographic and clinical features are shown in Table 1.

Table 1. Demographic characteristics of the patients.

	n	%
Gender		
Male / Female	40/71	64/36
Age (years)	62.61 ± 12.69 years	
<65	64	57.7
>65	47	42.3
Smoking history (Pack/Year)	36.5 ± 17.5	
Never	11	9.9
Active	16	14.4
Former	84	75.7
Department		
Thoracic surgery	36	32.4
Cardiovascular surgery	75	67.6
CCI		
0	13	11.7
1	19	17.1
2	61	55.0
3	13	11.7
4	4	3.6
5	1	0.9
Pneumonia +/–	37/74	33.3/66.7

In our study, 64.7% of pneumonectomy patients had complications. Significant risk factors for pneumonia were identified as thoracic surgery, CCI > 2, steroid usage, high ASA score, postoperative nasogastric tube usage, central venous catheterization, postoperative early mobilization, and TPN (Table 2).

The mortality rate was 17.4% overall (n = 20) and 48.6% (n = 18) among patients with pneumonia. Eleven of the deceased patients (14.3%) had cardiovascular surgery and 9 (24.3%) had thoracic surgery.

Cost analysis of patients with postoperative pneumonia revealed a significant difference in surgery costs between patients with and without pneumonia. Laboratory costs increased proportionately in patients with pneumonia (628.7 TL [91.2 – 3,443.1 TL]; $p < 0.001$) (TL = Turkish lira). The costs of radiological tests (chest x-ray and CT) were significantly higher in patients with pneumonia (136.5 TL [0 – 1,500.8 TL]; $p < 0.001$]. The mean cost of antibiotic therapy was 90.4 ± 58.6 TL for patients without pneumonia and 2,326.8 ± 3,293.1 TL for patients with pneumonia ($p < 0.001$). The mean cost of cultures was 10.4 ± 21.0 TL in patients without pneumonia and 121.7 ± 146.8 TL in patients without pneumonia ($p < 0.001$). These findings indicate that pneumonia is associated with higher antibiotic and culture costs. Cost of inpatient care was also significantly higher in patients with pneumonia due to their longer hospital stays. The mean overall cost for patients who had postoperative pneumonia was 8,211.7 TL (2,639.6 – 35,950.0 TL). This was twice the overall cost of patients who did not develop pneumonia. Comparison of costs for deceased and surviving patients showed that costs were significantly higher for patients who died. Factors associated with higher costs in our study were prolonged intubation, prolonged immobility, lack of respiration physiotherapy, and increased need for inotropic agents ($p < 0.001$; $p < 0.001$; $p = 0.009$; $p = 0.023$).

Discussion

The SENIC project remains one of the most extensive studies to evaluate the effectiveness of nosocomial infection control [3]. Data from SENIC indicated that healthcare-associated infections occur in approximately 4.5 per 100 hospital admissions and incurred a cost of 4.5 billion dollars [4]. Cost analysis studies are limited and generate broadly varying data due to the use of different metrics for cost assessment. In addition, most studies do not estimate losses resulting from loss of labor productivity and decreased quality of life, instead basing calculations on direct costs only. The most common approach in healthcare-related cost analysis studies is to compare costs calculated through observational epidemiologic follow-up of infected and uninfected patients [3]. In the present study, we retrospectively evaluated the effect of pneumonia after major thoracic and cardiovascular surgery on costs.

In developing countries like Turkey, both hospital infection rates and resistance rates are 3-5 times higher than the global average [5]. For this reason, hospital infections and prevention policies are especially pressing issues in economically developing countries. This is because nosocomial infections extend length of hospital stay by 10 days, increase hospital costs by 5-12 thousand dollars, and most importantly, cause a 2- to 3-fold increase in mortality compared to global averages, and the majority of these infections are preventable [5-7].

Table 2. Risk factors for pneumonia.				
Variable		Pneumonia – n (%)	Pneumonia + n (%)	P value
Sex	Male	47 (63.5)	24 (64.9)	1
	Female	27 (36.5)	13 (35.1)	
Age (years)		62.4 ± 12.4	63.0 ± 13.5	0.809
	<65	45 (60.8)	19 (51.4)	0.342
	>65	29 (39.2)	18 (48.6)	
Department	Thoracic surgery	18 (50)	18 (50)	0.010
	Cardiovascular surgery	56 (74.7)	19 (25.3)	
CCI	0-1	28 (37.8)	4 (10.8)	0.003
	>2	46 (62.2)	33 (89.2)	
Steroid use		1 (1.4%)	5 (13.5%)	0.015
Hospitalization in the last 6 months		18 (24.3%)	5 (13.5%)	0.282
Antibiotic use in the last 6 months		11 (14.9%)	8 (21.6%)	0.533
ASA score	2	36 (48.6)	11 (29.7)	0.025
	3	38 (51.4)	24 (64.9)	
	4	0	2 (5.4)	
Postoperative nasogastric tube		1 (1.4)	9 (24.3)	<0.001
Peripheral artery catheterization		16 (21.6)	15 (40.5)	0.036
Central venous catheterization		54 (73)	34 (91.9%)	0.020
Surgery duration (minutes)		330 (35 - 480)	240 (60 - 540)	0.074
Surgery type	Open	74 (100)	36 (97.3)	0.333
	Thoracoscopic	0	1 (2.7)	
Surgery status	Emergent	1 (1.4)	1 (2.7)	1
	Elective	73 (98.6)	36 (97.3)	
Need for inotrope		11 (14.9%)	9 (24.3%)	0.337
Day of mobilization		3.32 ± 16.94	11 ± 13.16	<0.001
TPN		-	17 (45.9%)	<0.001

Abbrev.: CCI: Charlson Comorbidity Index, DM: Diabetes mellitus, TPN: Total parenteral nutrition

One of the main objectives of our study was to identify the effect of nosocomial infections on length of stay. In our study, length of stay increased by approximately 2-fold in the presence of pneumonia ($p < 0.001$). A review of national and international studies revealed that nosocomial infection extended length of stay by 2 to 33.5 days, usually in the range of 15-20 days. The most comprehensive meta-analysis on this subject, performed by Durand-Zaleski et al. [8] evaluated more than 40 studies performed only in ICUs and showed that the nosocomial infections extended length of stay by 5 to 21 days. The Pennsylvania Healthcare Cost Containment Council in the USA, which has conducted one of the most extensive studies on the subject, reported in 2012 that hospital infections add an average of 16.9 days to length of stay [9]. Mundyet al. found that VAP prolonged length of stay by 6 days, whereas Karaoğlan et al. reported an additional 15.7 days due to VAP [10,11]. Cocanour et al. [12] reported that the average length of stay was 6.4 days for intensive care patients without infection and 21.6 days for those with infection.

Another important aspect of our study is the correlation between nosocomial infection and mortality. The mortality rate was significantly higher among patients who developed postoperative pneumonia than in patients with no infection (48.6% vs. 2.7%). In a study conducted in ICUs, Madani et al. [13] found that mortality rates were 75.1% higher in catheter-associated bloodstream infections, 56.7% higher in VAP, and 18.7% higher in urinary tract infections. Erbay et al. [14] detected a significant difference in mortality between patients with

and without VAP in the ICU. Furthermore, in a review by Yalçın on cost analyses of nosocomial infections, it was determined that reported additional mortality due to nosocomial infections varied from 4% to 33% [15]. Patients who undergo major surgery in the thoracic and cardiovascular surgery departments are distinct because they are older, usually have multiple comorbidities and risk factors, and are immunodeficient due to malignancy and treatment.

Thomas et al. [16] reported a 30-day mortality rate of 5.7% in patients with lung cancer who underwent pneumonectomy. The postoperative complication rate was 33%. Sezen et al. [17] had a pneumonia rate of 18.8% in complementary pneumonectomy patients. In our study, 64.7% of pneumonectomy patients had complications. Complication rate and pneumonia rate were higher than in literature. We think that is due to preoperative selection criteria of our patients. In our study, comorbidities were observed to be more common in patients who performed pneumonectomy. On the other hand, we did not evaluate the preoperative general conditions of these patients.

In their meta-analysis on post-cardiac surgery VAP, He et al. [18] noted that it is necessary to improve cardiac and renal functions, treat chronic pulmonary disease, and control pulmonary hypertension preoperatively to reduce the risk of pneumonia and avoid aggressive antibiotic treatment. In our study, we found that risk of postoperative pneumonia increased in patients with a CCI > 2. Preoperative steroid use was also found to increase the risk of pneumonia.

The main aim of our study was to determine the additional cost burden caused by nosocomial infections. Additional costs due to nosocomial infections are a major burden on the healthcare system in developing countries, as in developed countries. It was reported that nosocomial infections added 28.4–33.8 billion dollars in costs to the USA healthcare system in 2007 [3]. In the UK, the annual additional cost of nosocomial infections to hospitals alone was 1 billion pounds [19].

In our study, the average total hospital cost was calculated as 3,917.5 TL for patients who did not have postoperative pneumonia and 8,211.7 TL for patients who developed pneumonia, which is a 2-fold increase. In a meta-analysis by Stone et al. [20], one of the most extensive reviews on the subject, the highest costs related to nosocomial infection were due to catheter-associated bloodstream infections (38,703 USD), followed by pneumonia (17,677 USD). In the same study, the cost of surgical site infection was 15,646 USD, and the average cost attributable to infection was 13,973 USD. In another study by Kollef et al., the cost for patients who developed VAP in the ICU was 39,828 USD [21]. Meriç et al. [22] in a 2008 study determined that extra cost due to nosocomial infections in the ICU was 2,503 USD, while Hançer et al. determined in 2009 that the additional cost attributable to bloodstream infections alone in the ICU was 14,045 USD [23]. In a study performed by Rosenthal et al. in 2005, total additional cost was 2,255 USD and antibiotics cost a further 996 USD [24]. Some researchers have claimed that hospitalization costs were the most important factor increasing cost, whereas others implicated the cost of antibiotics. In the present study, antibiotics accounted for 38.9% of the total average additional cost of 2,327 TL. We believe that selecting appropriate treatment and administering treatment for the appropriate duration may be important steps in the reduction of hospital costs.

In our study, we found that hospitalization costs for patients with pneumonia increased by 2.18-fold and 1,223 TL compared to patients without pneumonia, and hospitalization was the second most expensive item (30.6% of total cost) after antibiotics. In contrast to our results, because labor costs are much higher in Europe and the USA compared to Turkey, hospitalization and service costs account for the largest proportion of hospital costs in studies conducted in those countries. In a study performed in the UK, it was reported that general hospital costs and nursing and care costs comprise approximately 64% of the total additional costs, while a study performed in Belgium showed that 58% of total cost was attributable to prolonged length of stay [25,26].

Infection control measures can prevent costly infections. However, better access to personnel and financial resources are needed to support infection control activities and prevent nosocomial infection. To highlight these needs, it is important for studies on hospital epidemiology and healthcare-related outcomes to demonstrate the financial burden of nosocomial infections [27]. Costs can also be reduced by restricting antibiotic use and encouraging the rational use of medicines. Without rational drug use, infection control programs cannot be effective [28].

Limitations of the study

This study was retrospective and included a small number of patients. The main limitations are that patients were recruited from two different surgical departments and our cost analysis did not take into account loss of labor productivity. The inclusion of only pneumonectomy patients apart in thoracic surgery creates bias.

As a conclusion, postoperative pneumonia significantly increases healthcare costs. Identifying and mitigating these factors will reduce both the incidence of infection and the associated costs. Because infection control measures help avoid infection and thereby infection-related costs, it is critically important to support infection control activities and prevent nosocomial infections.

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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Original Article

Blood pleurodesis for air leak after pulmonary resection

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ABSTRACT

Background: Blood pleurodesis procedures were generally performed for patients with prolonged air leakage due to pneumothorax. This study investigates the use of blood pleurodesis in patients with prolonged air leak after lung resection and the variables affecting its success.

Materials and Methods: A total of 493 patients who underwent anatomical lung resection for non-small cell lung cancer between January 2012 and December 2016 were evaluated retrospectively. 68 (13.7%) patients who underwent blood pleurodesis were included the study group. The success rate of the procedure was evaluated according to age, gender, side and type of the surgery, histopathology, and the expansion of the lungs and air leakage.

Results: The success rate was not related to age, sex, side of the operation, histopathology, and type of the resection, while it was found to be statistically significant for the air leakage score ($p < 0.001$). The procedure was successful in 46 (67.6%) patients and failed in 22 (32.3%) patients.

Conclusions: The blood pleurodesis is a safe, effective and low cost method for treatment of postoperative air leakage in patients with anatomical lung resection for primary lung carcinoma.

Key Words: blood pleurodesis, autologous blood pleurodesis, prolonged air leakage, lung resection

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Introduction

Prolonged air leakage is a very common complication after lung resection. Air leakage prolongs hospitalisation, increases morbidity and hospital costs. Therefore, many methods have been developed to prevent air leakage. Blood pleurodesis, first performed by Robinson et al. in 1987 [1], has been presented as an ideal method for this purpose with almost no cost and very few complications.

Blood pleurodesis procedures described in the literature were generally applied to cases of prolonged air leakage after pneumothorax. Fewer reports have described the use of blood pleurodesis in cases of prolonged air leakage after lung resection.

Blood pleurodesis was shown to effectively resolve prolonged air leakage in studies with few cases, but the factors affecting its efficacy have not been determined. Therefore, the present study was performed to define the factors that affect the results of blood pleurodesis applied between 2012 and 2017.

Materials and Methods

This retrospective study included patients undergoing pulmonary resection and blood pleurodesis due to air leakage between January 2012 and December 2016. The institutional ethics committee approved the study, and all patients provided informed consent. The study population comprised 493 patients aged 18-80 years who underwent anatomical lung resection. Patients undergoing pneumonectomy and non-anatomical lung resection were not included in the study. Those undergoing thoracoscopic lung resection were excluded, whereas those undergoing operations performed with standard posterolateral thoracotomy were included. In the postoperative period, all patients received pulmonary rehabilitation assistance motivation for early mobilisation. Expectorant treatment was included with analgesia. Patients' chest tubes were connected to suction devices. Patients with persistent air leakage despite these procedures were included in the study. As blood pleurodesis would be meaningless in patients with considerably bloody drainage, patients with bloody drainage were excluded.

blood pleurodesis procedure was performed at the bedside in patients with air leakage. Autologous venous blood (100 cc) was taken under aseptic conditions and introduced through the cap-cone connector of the chest drain to prevent coagulation in the tube. To prevent air trapping, the chest drain was hung without being clamped on a serum hanger with a loop, allowing the release of air (Figure 1).

Figure 1. Elevation of the thoracic drainage system during blood pleurodesis procedure.

No heparin was added to the blood given, but all patients received prophylactic low-molecular-weight heparin (IU/0.4 mL). No sedation or analgesia was required before the procedure. The position of the patient was changed every 30 min, taking special care to manage the drain. The drain was released after 3 h; if air leakage continued, the procedure was repeated the following day. Patients' chest tubes were removed when air leakage had been resolved. Pleurodesis was deemed successful when patients were discharged with no additional procedure (e.g. pneumoperitoneum, re-thoracotomy, Heimlich valve placement).

Air leakage in the drain was classified as follows [2-4]: 0, no leakage; 1, leakage as 1-2 bubbles during coughing; 2, intense air leakage during coughing; and 3, continuous air leakage during expirium and inspirium.

The success of the procedure was evaluated according to age, sex, side and mode of surgery, malignant/benign differentiation and the degrees of lung expansion and air leakage in the drain.

The required permission was obtained from the patient shown in the figure.

Statistical Analysis

Descriptive statistics were applied to the patients' demographic and clinical data. The chi-squared test was used to examine correlations between categorical variables, and the Student's t, Mann–Whitney U and Kruskal–Wallis tests were used for continuous variables. In all analyses, $p < 0.05$ was taken to indicate statistical significance. SPSS (ver. 22; SPSS Inc., Chicago, IL, USA) was used for the calculations.

Results

Of the 68 patients undergoing blood pleurodesis, 63 and 5 had malignant and benign causes, respectively. The mean age of the patients was 56.9 ± 8.4 (min., 24; max., 78) years. The patients consisted of 61 (89.7%) males and 7 (10.2%) females. Sixteen (23.5%) patients underwent blood pleurodesis on postoperative day 2; the procedure was performed in 14 (20.5%) patients on postoperative day 3, 5 (7.3%) patients on postoperative day 4, 155 (22%) patients on postoperative day 5, 5 (7.3%) patients on postoperative day 6, 6 (8.8%) patients on postoperative day 7, 1 (1.4%) patient on postoperative day 8, 4 (5.8%) patients on postoperative day 9 and 2 (2.9%) patients on postoperative day 10. The mean timing was 5.3 days. The procedure was repeated twice in 22 (32%) patients, three times in 7 (10.2%) patients and four times in 2 (2.9%) patients. Empyema with no reproduction in culture developed in two (2.9%) patients and was controlled by nonspecific antibiotherapy. The procedure was successful in 46 (67.6%) patients and failed in 22 (32.3%) patients.

Expansion of the lungs, visualised by posteroanterior chest radiography (PACR), had no significant impact on the procedure (Table 1).

Table 1. The effect of the expansion rate of the lungs on the success of the procedure.

	successful	unsuccessful	p value
Unexpanded (n:43)	27 (62.7%)	16 (37.2%)	0.262
Expanded (n:25)	19 (76%)	6 (24%)	

Prolonged air leakage was seen most commonly after right-side surgery, particularly right upper lobectomy (RUL; Table 2).

Table 2. The success of the procedure according to the side and type of the surgery.

Side of Operation	Type of surgery	Success of the procedure	Expanded lung	Unexpanded lung
Right (n:43)	RUL (± sleeve): 23 (53.4%)	15 (65.2%) successful	6 (40%)	9 (60%)
		8 (34.7%) unsuccessful	3 (37.5%)	5 (62.5%)
	RLL: 10 (23.2%)	7 (70%) successful	4 (57.1%)	3 (42.8%)
		3 (30%) unsuccessful	1 (33.3%)	2 (66.6%)
	RUBL: 6 (13.9%)	4 (66.6%) successful	0 (0%)	4 (100%)
		2 (33.3%) unsuccessful	1 (50%)	1 (50%)
	Right lower segmentectomies: 3 (6.9%)	2 (66.6%) successful	1 (50%)	1 (50%)
		1 (33.3%) unsuccessful	0 (0%)	1 (100%)
	RLBL: 1 (2.3%)	1 (100%) successful	0 (0%)	1 (100%)
Left (n:25)	LUL (± sleeve):13 (52%)	7 (53.8%) successful	5 (71.4%)	2 (28.5%)
		6 (46.1%) unsuccessful	0 (0%)	6 (100%)
	LLL (±sleeve):12 (48%)	10 (83.3%) successful	3 (30%)	7 (70%)
		2 (16.6%) unsuccessful	1 (50%)	1 (50%)

However, the rate of successful application did not differ significantly according to the side or type of surgery (Table 3).

The success rate of blood pleurodesis decreased markedly with increasing air leakage score ($p < 0.001$, Table 4). This rate was not affected by patient age or sex, side of surgery, mode of lobectomy, malignant/benign status, or lung expansion determined by PACR (Table 5).

Table 3. Surgery type according to the success of the procedure.

Side of operation	Success Rate	Type of Surgery
Right (n:43)	29 (67.4%) successful	15 (51.7%) RUL
		7 (24.1%) RLL
		4 (13.7%) RUBL
		2 (6.8%) Right lower segmentectomies
		1 (3.4%) RLBL
	14 (32.5%) unsuccessful	8 (57.1%) RUL
		3 (21.4%) RLL
		2 (14.2%) RUBL
		1 (7.1%) Right lower segmentectomies
	17 (68%) successful	10 (58.8%) LLL
		7(41.1%) LUL
Left (n:25)	8 (32%) unsuccessful	6 (75%) LUL
		2 (25%) LLL

Table 4. The effect of air leakage score on the success of the procedure.

Leakage score	successful	unsuccessful	p value
1: 36 (52.9%)	34 (94.4%)	2 (5.5%)	
2: 27 (39.7%)	12 (44.4%)	15 (55.5%)	<0.001
3: 5 (7.3%)	0 (0%)	5 (100%)	

Table 5. The variables effecting the success rate of the blood pleurodesis procedure.

	unsuccessful	successful	p value
Age	57.18±7.14	56.8±9.12	0.703
Unexpanded lung	16 (37.2%)	27 (62.8%)	0.262
Expanded lung	6 (24%)	19 (76%)	
Gender			
Male	21 (34.4%)	40 (65.5%)	0.281
Female	1 (14.3%)	6 (85.7%)	
Side of Operation			
Right	14 (32.6%)	29 (67.4%)	0.962
Left	8 (32%)	17 (68%)	
Leakage score			
1	2 (5.6%)	34 (94.4%)	
2	15 (55.6%)	12 (44.4%)	<0.001
3	5 (100%)	0 (0%)	
Right side			
RUL	8 (34.8%)	15 (65.29%)	0.789
RLL	3 (30%)	7 (70%)	
Left side			
LUL	6 (46.2%)	7 (53.8%)	0.202
LLL	2 (16.2%)	10 (83.3%)	
Histopathology			
Malign	19 (31.7%)	41 (68.3%)	0.740
Benign	3 (37.5%)	5 (62.5%)	

Discussion

Prolonged air leakage is one of the most frequent complications after lung resection [5-7]. Complications arising from lengthy hospitalisation further prolong hospitalisation and increase costs. New, cost-effective methods to control prolonged air leakage with minimal adverse effects should be investigated.

The Heimlich valve, pneumoperitoneum, bronchoscopic valve placement and re-thoracotomy in appropriate patients are more invasive choices that are recommended in cases of prolonged air leakage and are associated with the extension of hospitalisation [5]. Various chemical agents have been used for pleural adhesion in most patients with prolonged air leakage. In general, talc, tetracycline, minocycline, OK-432 (picibanil), povidone-iodine and autologous blood have been used for the treatment of prolonged air leakage in cases of pneumothorax. Blood pleurodesis is used more commonly than these agents because of its significantly reduced adverse effects [8].

Blood pleurodesis was first described by Robinson et al. in 1987 [1] as an alternative to chemical pleurodesis and surgery. It was applied in cases of pneumothorax, and showed a success rate of 85% in a series of 25 patients [1]. In 1992, Dumire et al. [9] first reported the use of blood pleurodesis for prolonged air leakage after resection in a single case; after the failure of tetracycline pleurodesis during 5 weeks of follow-up with a drain, the air leakage ceased after blood pleurodesis. Rivas de Andrés et al. [10] conducted a prospective cohort study of the administration of blood pleurodesis in cases of prolonged air leakage after lung resection. Six patients undergoing surgery for lung cancer and exhibiting prolonged (>10 days) air leakage were followed for a mean of 26.1 months after blood pleurodesis and evaluated. The amount of venous blood used in the procedure was 50-250 cc. The autologous blood was introduced from the end of the chest drain, which was temporarily separated from the water seal. In a letter to the editor, Shackcloth et al. [11] reported on two technical alternatives for this method; they stated that 5, rather than 10, days of air leakage was sufficient to prompt blood pleurodesis, and they recommended the use of a Luer-lock connector instead of separation of the drain from the water seal before the procedure. Drains with cap-cone connectors are used in our clinic, which enable the

provision of intra-drain liquid without separation from the water seal.

Decisions about the timing of blood pleurodesis should be made carefully, given the effect of the procedure on the duration of hospitalisation. Cerfolio et al. [2] reported that when postoperative air leakage continues on day 4, the likelihood of its continuance until day 7 is 83%. In such cases, as suggested by Rivas de Andrés et al. [10], it would be more useful to plan blood pleurodesis in the early period instead of waiting for 10 days. However, no consensus on the timing of blood pleurodesis has been established. In the present study, the mean timing for blood pleurodesis was 5.3 days.

In a prospective cohort study performed in 2004, Lang-Lazdunski et al. [12] investigated the effects of blood pleurodesis on prolonged air leakage in 11 patients undergoing surgery for malignant and non-malignant causes. They took a more rigid approach to complications relative to that taken in a prospective cohort study conducted by Çağırıcı et al. [13] with cases of pneumothorax, which yielded the greatest series of adverse effects reported to date. In this study, to prevent bacterial colonisation, 50 cc autologous blood was used, and the drain was clamped after a single pleurodesis procedure. In an editorial published in 2005, Jones et al. [14] stated that patients with air leakage could not tolerate drain clamping and recommended no drain clamping to avoid air trapping, but rather hanging of the drain on the serum hanger with a loop to allow the release of air. With this method, which is preferred in our clinic, the blood remains in the thorax because the drain is higher than the patient's body and air release is provided because the drain lumen remains open. Clamping of the drain is not recommended in patients with air leakage. Patients with a leakage score of 3 may have temporary air blockage due to clotting in the drain during the blood pleurodesis procedure. Caution is advised in cases in which subcutaneous emphysema and tension pneumothorax may develop. In a prospective randomised study first presented in 2002 and published in 2006, Shackcloth et al. [15] argued that because bacterial colonisation–related complications occurred in cases of prolonged air leakage without blood pleurodesis, these complications could not be related directly to this procedure. Despite the large number of cases included in the present study, empyema with no reproduction in culture developed in only two patients and was controlled by nonspecific antibiotherapy. In a randomised study of 25 patients, Andreetti et al. [16] suggested that 100 cc was more effective than 50 cc autologous blood, in contrast to the results reported by Lang-Lazdunski et al. [12]. Little consensus exists regarding the appropriate amount of blood to use for blood pleurodesis. In our clinic, 100 cc autologous blood is used.

Reports on the use of blood pleurodesis include those by Droghetti et al. [4] (retrospective cohort study, 21 patients), Ahmed et al. [17] (5 patients), and Athanassiadi et al. [18] (prospective cohort study, 20 patients undergoing surgery for malignant/benign causes). Özpolat [19] reported the first application of blood pleurodesis for air leakage developing after hydatid cyst operations.

To our knowledge, this study is among the largest (with 68 patients) to examine the experience with blood pleurodesis in patients with prolonged air leakage after lung resection. The success rate of the procedure was 67.6%, similar to previous reports [15,20-22]. The main limitations of this study include its retrospective design and the lack of a control group for comparison.

The mechanism of spontaneous regression of air leakage after lung resection is not clear. However, it is likely due to the closure of minimal tears in the visceral pleura following visceral-parietal apposition and adhesion [5]. Blood pleurodesis has two effects on air leakage [1,9]. The 'patch' effect, in which venous blood introduced into the thorax prevents air leakage by covering lacerations on the visceral pleura, is the most important. This mechanical effect is effective for early air leakage and is in fact not pleurodesis. Although it does not correspond to the nomenclature, this 'patch' effect of blood pleurodesis is a unique feature that cannot be obtained with chemical pleurodesis agents. The second, i.e. 'desis', effect of blood pleurodesis involves adhesion in the pleural leaves due to the long-term organisation of the introduced blood. Although some authors have recommended the opposite [23], the clinician does not need to wait for the lung to be fully expanded before performing blood pleurodesis. Indeed, lung expansion had no significant effect on the efficiency of the procedure in the present study. In our clinic, low-molecular-weight heparin is administered subcutaneously to all patients postoperatively for prophylaxis. No adverse effect of prophylactic heparin on the success of blood pleurodesis has been reported [12].

In the present study, procedures on the right side, especially RUL, more commonly led to the requirement for blood pleurodesis. The risk of postoperative air leakage is higher following upper lobectomy because the potential air space remaining in the apical area prevents pleural apposition and adhesion [2,24,25]. Approximately 25% of cases of prolonged air leakage develop after upper lobectomies, and this leakage is the sole complication in 81% of these cases [6]. Emphysema, chronic obstructive pulmonary disease and incomplete fissure are also responsible for postoperative prolonged air leakage [2,5,6,25,26]. On the other hand, in the present study, the effects of the level and side of lobectomy on the efficiency of blood pleurodesis were not significant, and the pleural approach may not be necessary for blood pleurodesis due to the 'patch' effect.

In the present study, factors such as age, sex and cause of resection (malignant/benign) did not influence the success of pleurodesis, but the success rate decreased with increasing air leakage score ($p < 0.001$). As air trapping may cause tension pneumothorax in patients with severe air leakage, the performance of blood pleurodesis with two chest drains in these patients is safer.

Several methods are available for the treatment of air leakage, including prolonged tube thoracostomy, chemical pleurodesis and surgical repair, but little consensus has been achieved on the role and timing of blood pleurodesis. Several prospective studies showed that autologous blood pleurodesis has superior outcomes in cases of persistent air leakage in terms of success rate, sealing time and complication rates in comparison with conservative treatment without opposition. No unpredictable reaction that may develop with the application of talc, the most common pleurodesis agent, was seen in patients undergoing blood pleurodesis in the present study. In cases requiring re-thoracotomy and in which blood pleurodesis was not effective, blood pleurodesis caused less inflammation than talc pleurodesis and allowed dissection because it did not cause intense adhesions. Therefore, blood pleurodesis is superior to talc pleurodesis.

New products, such as patches, glues and sealants, are currently being developed to help treat air leakage in the operation room. However, some of these products are expensive and their application requires special equipment. Here, we suggest a simple and inexpensive procedure that is available to all thoracic surgeons to help manage air leakage postoperatively. This method should at least be tried, even in patients for whom definite success is not expected.

As a conclusion, blood pleurodesis is a simple, safe, painless, effective and low-cost treatment for postoperative air leakage in patients who have undergone anatomical lung resection for primary lung carcinoma. The main advantages of the procedure are the use of the patient's own blood and the lack of requirement for additional equipment. It can also be applied in cases in which lung expansion has not been achieved.

Declaration of conflicting interests

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Original Article

Clinical and biochemical parameters for the selective use of chest computed tomography in pediatric blunt trauma patients

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ABSTRACT

Background: The aim of the present study was to investigate the predictive role of clinical and biochemical parameters whether thoracic CT scan rate could be decreased in high energy blunt thoracic trauma in children.

Materials and Methods: This retrospective study included 15 pediatric patients who received chest computed tomography, out of 165 consecutive high-energy pediatric trauma patients admitted to our pediatric emergency department within one year. 15 Patients were divided into two groups. Normal tomography findings (Group I; n = 8) and revealing thoracic pathology (Group II; n = 7). The groups were compared in terms of age, gender, weight, type of trauma, fever, pulse and respiratory rate per minute, systolic blood pressure, peripheral blood oxygen saturation and biochemical parameters. Glasgow Coma Scale, Pediatric Trauma Score, Modified Trauma score, and Injury Severity Score were also calculated and evaluated.

Results: There was no statistically significant difference between the two groups in terms of age, gender, weight, type of trauma, fever, respiratory rate, systolic blood pressure, and pulse rate ($p > 0.05$), whereas a statistically significant difference was determined between two groups with respect to peripheral blood oxygen saturation ($p = 0.013$), white blood cell count ($p = 0.008$), blood glucose ($p = 0.003$), alanine transaminase ($p = 0.033$), and aspartate transaminase ($p = 0.012$). When the trauma scores were evaluated; Glasgow Coma Score ($p < 0.001$), Pediatric Trauma Score ($p = 0.002$), and Modified Trauma Score ($p < 0.001$) were found to be statistically low in the second group while Injury Severity Score ($p = 0.001$) was higher.

Conclusions: Peripheral blood oxygen saturation, white blood cell count, blood glucose, alanine transaminase, aspartate transaminase, and Glasgow Coma Score, Pediatric Trauma Score, Modified Trauma Score, Injury Severity Score shall be predictive parameters for a thoracic pathology and need for chest computed tomography.

Key Words: pediatric blunt thoracic trauma, computerized chest tomography, predictive parameter

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Introduction

Blunt chest trauma is the second most common cause of deaths after head trauma in children [1]. Although seen rarely, it is an indicator of a high energy trauma and is associated with increased mortality [2]. It has been reported that multitrauma with thoracic trauma increases the frequency of mortality by 20 times in children [3].

Chest x-ray (CXR) is the first imaging method in patients who are suspected of having thoracic trauma because it has less radiation exposure and cheaper. Computed tomography (CT) is used for more limited indications because it contains 100-500 times more radiation and expensive. Therefore, CT scan is recommended in the presence of abnormal physical examination findings and high-energy trauma [3-8]. Although some authors suggest that abnormal findings in thoracic CT cannot make any difference in acute treatment [9,10], others suggest a more widespread use of CT because of the change in the management of 10-20% of the patients [11-16].

In this study, we sought to determine the clinical and biochemical parameters to identify a subset of patients for the selective use of chest CT in pediatric blunt trauma patients.

Materials and Methods

A total of 165 high-energy trauma patients, admitted to our pediatric emergency department within one year were retrospectively evaluated. 15 patients who had screened with chest CT were included in the study. Patients who had found negative for injury were grouped as Group I and with positive findings as Group II. Age, gender, weight, mechanism of trauma, fever, pulse, the respiratory rate per minute, systolic blood pressure, and peripheral blood oxygen saturation were recorded. Glasgow Coma Score (GCS), Pediatric Trauma Score (PTS), Modified Trauma Score (MTS) and Injury Severity Score (ISS) were also calculated for all patients.

Also, biochemical parameters such as white blood cell count, neutrophil count, hematocrit, platelet count, blood glucose, urea, creatinine, creatinine kinase, amylase, alanine aminotransferase (ALT), aspartate aminotransferase (AST), sodium, potassium, troponin, blood pH, pCO2, pO2, HCO3, base deficit, prothrombin time (PT), activated partial thromboplastin time (aPTT), and INR were studied. With the additional imaging methods, the presence of head and abdominal trauma, and extremity fractures were investigated. The necessity of intensive care unit treatment and length of stay, the need for surgery and mortality rates were evaluated.

Statistical Analysis

SPSS 20.0 (SPSS Inc., Chicago, Illinois, USA) was used for statistical analysis. In the comparison of the numerical data, Student's t-test was used to compare the normal distribution parameters, and the Mann-Whitney U test was used for the parameters that had abnormal distribution. Chi-square test was used to compare the categorical data. $P < 0.05$ was considered as statistically significant.

Results

Out of the 15 cases that had chest CT, eight cases were negative for injury (Group I) and seven cases revealed pathology (Group II). CXR revealed pathology in four (57%) of the patients of Group II. The pathologies detected in chest CT were as follows: unilateral contusion in three cases, bilateral contusion in one case, unilateral contusion and pneumothorax on the same side in one case and unilateral pneumothorax in two cases. There were no differences regarding age, gender, weight and the mechanism of trauma in patients with normal and abnormal chest CT. Fever, respiratory rate, systolic blood pressure and pulse values of the patients were similar. Demographic data and vital signs of patients were shown in Table 1.

Table 1. Demographic data and vital signs of patients.

Parameters	Group I n=8 Median (min-max)	Group II n=7 Median (min-max)	P* value
Age (year)	6 (6-12)	1 (1-3.5)	>0.05
Sex (male)	6 (%75)	5 (%71.4)	>0.05
Weight (kg)	20 (20-40)	11.5 (10-14.5)	>0.05
Mechanism of injury Fall-down Pedestrian Passenger Cyclist	 2 2 3 1	 2 3 1 1	>0.05
Fever	36.5 (36.5-37)	36.7 (36.7-37)	>0.05
Respiratory rate/min	30 (14-30)	30 (16-40)	>0.05
Systolic blood pressure (mmHg)	117 (104-117)	102 (67-112)	>0.05
Pulse/min	98 (87-100)	118 (100-140)	>0.05
Oxygen saturation (%)	98 (98-100)	94 (76-98)	0.013

** Mann-Whitney U test*

Peripheral blood oxygen saturation value was lower in Group II compared to Group I and it was significant ($p < 0.05$). White blood cell count ($p = 0.008$), glucose ($p = 0.003$), ALT ($p = 0.033$), and AST ($p = 0.012$) values were also significantly higher in Group II (Table 2).

Table 2. Blood test results.

Parameters	Group I n=8 Median (min-max)	Group II n=7 Median (min-max)	P* value
WBC (103/μL)	12300 (7150-12300)	23000 (15000-32000)	0.008
Neutrophil (103/μL)	5600 (5200-5600)	12500 (5500-20000)	>0.05
Hematocrit (%)	36 (34-36)	37 (32-38)	>0.05
Platelet (106/μL)	277 (232-277)	397 (354-480)	>0.05
Glucose (mg/dL)	131 (120-131)	171 (147-274)	0.003
Urea (mg/dL)	28 (15-28)	29 (23-33)	>0.05
Creatinine (mg/dL)	0.6 (0.6-0.7)	0.5 (0.5-1)	>0.05
Creatinine kinase (mg/dL)	205 (125-205)	526 (318-692)	>0.05
Amylase (mg/dL)	50 (23-57)	68 (55-105)	>0.05
Alanine amino transferase (U/L)	29 (7-30)	92 (46-884)	0.033
Aspartate transaminase (U/L)	29 (16-29)	227 (104-990)	0.012
Sodium (mmol/L)	138 (137-138)	135 (132-138)	>0.05
Potassium (mmol/L)	3.6 (3.5-3.6)	3.7 (3.5-4.2)	>0.05
Troponin (mg/dL)	0.9 (0.6-0.9)	0.05 (0.02-1.1)	>0.05
pH	7.38 (7.25-.39)	7.38 (7.30-7.39)	>0.05
pCO2 (mmHg)	38 (27-39)	33 (31-49)	>0.05
pO2 (mmHg)	97	98	>0.05
HCO3 (mEg/L)	19.3 (18.4-19.5)	19.1(15.8-24)	>0.05
Base excess (mEG/L)	-4.7 (-5.4)- (-4.7)	-5.4 (-10.7)-(-3.4)	>0.05
Prothrombin time (PT) (sec)	11.7 (10.6-12.9)	11.8 (11.1-12)	>0.05
Activated partial thromboplastin time (aPTT) (sec)	22.7 (20.4-25.1)	24 (21-26.9)	>0.05
International normalized ratio (INR) (%)	1 (0.9-1.1)	1 (0.9-1.1)	>0.05

** Mann-Whitney U test*

When the trauma scores were evaluated, GCS ($p < 0.001$), PTS ($p = 0.002$), MTS ($p < 0.001$), and ISS ($p = 0.001$) were significantly worse in Group II (Table 3).

The rates of additional pathology in the abdominal and cranial CT and the likelihood of an extremity fracture were similar. While the rate of admission to the intensive care unit was higher in Group II patients, there was no significant difference in the incidence of surgical intervention ($p > 0.05$) and mortality rates ($p > 0.05$) (Table 3).

Table 3. Trauma scores and other findings.

Parameters	Group I (n=8) Median (min-max)	Group II (n=7) Median (min-max)	P* value
Glasgow Coma Score (GCS)	15 (14-15)	11 (8-14)	<0.001
Pediatric Trauma Score (PTS)	10 (5-11)	6 (0-7)	0.002
Modified Trauma Score (MTS)	7.5 (7.5-7.5)	6.7 (5.3-7.5)	<0.001
Injury Severity Scores (ISS)	14 (2-14)	48 (29-59)	0.001
Pathological findings with abdominal CT	0	4	>0.05
Pathological findings with cranial CT	2	5	>0.05
Extremity fracture	1	1	>0.05
Admission to the intensive care unit	0	5	0.018
Length of stay in intensive care (day)	-	6 (3-20)	>0.05
Surgical intervention	2	4	>0.05
Exitus	0	1	>0.05

** Mann-Whitney U test*

Discussion

The management of pediatric trauma patients presenting to the emergency department with a suspected trauma mechanism is controversial. Such as the fact that the examination of the abdomen alone is not reliable in the diagnosis of abdominal trauma, the sensitivity and specificity of the laboratory tests alone are low [17,18]. CXR and pelvic radiographs are thought to have low sensitivity [12,17,19]. Also, trauma-specific focused ultrasonography has been shown to be less sensitive in the pediatric population compared to adults, and its role is still uncertain [20].

Chest CT was used as a first line imaging modality in adult blunt trauma patients, but no official guidelines for pediatric trauma patients have been published [13]. Since there is a lack of consensus, the overuse of chest CT has been contributed in pediatric trauma patients. However, since children are ten times more susceptible to radiation concerning cancer morbidity and mortality and this sensitivity increases up to 14 fold with the younger age, the concept of malignancy caused by the radiation taken during CT is discussed by many authors [21-23]. Therefore, because of the risk of radiation exposure during CT imaging, routine use of CT as a primary screening tool in the evaluation of traumatic injuries is questioned [8,14,24]. In the study of Stephens et al., there was no change in chest CT utilization rates despite the pressures in reducing the use of chest CT at the initial examination of pediatric trauma patients [25]. For this reason, new markers should be determined separately from the chest radiograph in order to determine the patients who will benefit from chest CT. Khan et al, suggest that by utilizing clinical, biochemical and ultrasonographic parameters, almost ¾ th of the children with abdominal trauma could be avoided from unnecessary radiation by reducing the CT scan rate [26]. For this purpose, we investigated the predictive role of clinical and biochemical parameters whether chest CT rate could be decreased in high energy blunt thoracic trauma in children. A statistically significant difference was determined between two groups with respect to peripheral blood oxygen saturation, white blood cell count, blood glucose, ALT, and AST. Although we have small number of cases, these biochemical parameters shall be used but larger studies are needed.

In our study, the systolic blood pressure was lower and the pulse was higher. When the vital signs of the patients were evaluated, no difference was observed between the two groups. However, there was a relationship between low saturation values of patients and abnormal CT imaging. It was also consistent with the study of McNamara et al, which highlights that hypoxia was the easiest way to evaluate lung capacity and therefore thoracic trauma [27].

When the trauma scores of the patients were examined, GCS, PTS, and MTS were lower in the patients with abnormal chest CT, and the ISS was significantly higher. In the study by Peclet et al, patients with thoracic trauma were found to have higher ISS values than patients without thoracic injury (27 and 7, respectively; $p < 0.001$) [3]. Hence, there was no open fracture in both groups, and one patient had extremity fracture, we explain the high ISS values in patients with abnormal chest CT with the GCS that reveal mental state and consciousness and low systolic blood pressure. Again in the same study, the isolated thoracic injury was 5%, 20% were accompanied with abdominal trauma, and 35% with head trauma and 39% had thoracic, abdominal and head trauma together. In our study, the prevalence of patients' pathology in the abdomen or cranial CT was higher in patients who had abnormalities in their chest CT, but no statistically significant difference was found. Regarding the mechanism of trauma, there was not any difference between the groups as similar to that of Hershkovitz et al's study [10].

Ceran et al. reported that the most common pathology after thoracic trauma was pulmonary contusion [28]. This was followed by hemothorax, pneumothorax, and hemopneumothorax. In his article, Civil suggested that pneumothorax is the most commonly seen pathology in chest CT [29]. In our patients, as stated by Ceran et al, pulmonary contusion was more common than the others were. This difference is predicted to be due to the inclusion of blunt trauma patients in the study, and that the incidence of pneumothorax and hemothorax will increase more if penetrating injuries are involved.

In many studies, it is reported that chest CT increases the diagnosis of pediatric intrathoracic injury but does not change the management [9]. In our study, CXR determined the thoracic pathology in four cases but chest CT revealed additional pneumothorax in three cases (43%) and tube thoracostomy was performed.

We know that precise results cannot be obtained based on this study due to the limited number of pa-

tients. We planned this study as a preliminary study for giving the first results and planned to present it as the first step of a multi-center study.

As a conclusion we think that CT scan rate can be decreased by using trauma scores such as saturation, blood tests, GCS, ISS, MTS in patients with blunt trauma.

Declaration of conflicting interests

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Original Article

Advantages of surgical approach for multiple rib fractures

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ABSTRACT

Background: In this article, we present our study of surgical treatment of multiple rib fractures, which reduced pulmonary complications and recovery time.

Materials and Methods: From 2014 to 2016, a total 14 cases (8 male, 6 female, average age 59.6 years (range: 29-76)) who underwent plate fixation were included in the study. The cases were evaluated according to their demographic features, symptoms, radiological scans, numbers and locations of rib fractures, surgical approach performed and its results.

Results: The average number of fractures is 7.5 costa (range: 3-16). Multiple rib fractures were in the left hemithorax in nine cases, in the right hemithorax in two cases and were bilateral in three cases. While all cases had additional pulmonary pathology, 12 cases had different system pathologies. Ten out of 14 cases had flail chest. None of the cases underwent mechanic ventilation in the preoperative stage. Following the planning of their medical treatment based on their clinical condition, they underwent tube thoracotomy. Plate fixation surgery was performed for all cases in an average of one day. The average number of plates used is 3.2 plates (range: 2-5). In four cases, postoperative complications were observed. The average length of stay in hospital in the postoperative period was 7.6 days (range: 3-14).

Conclusions: Rib fractures, which often occur following blunt thoracic trauma, usually heal on their own and treatment is based on the symptoms. However, multiple rib fractures can cause morbidity such as increase in pulmonary complications, prolonged healing process, and reduced life quality or mortality due to complications. While there is no consensus on a specific treatment for rib fractures, open reduction and fixation in rib fractures, in particular those caused by blunt thoracic trauma, is a method of treatment with significant benefits including increase the life quality of the patient, and decrease in potential complications, length of stay in the hospital and cost.

Key Words: thoracic trauma, multiple rib fractures, rib fixation

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Introduction

Rib fractures occur with a rate of 35-40% following blunt thoracic trauma. They usually heal on their own and treatment is based on the symptoms [1]. However, multiple rib fractures can cause morbidity such as increase in pulmonary complications, prolonged healing process, and reduced life quality due to intensive and long lasting pain in rib fractures, inadequate inspirium and inadequate clearing of secretions or mortality due to complications. There is no consensus on a specific treatment for rib fractures.

We aim to contribute to such a consensus on treatment, through a study of surgical treatment of cases with multiple rib fractures caused by blunt thoracic trauma, which resulted in significant improvement in healing period and complication rates, presented along with literature review.

Materials and Methods

Fourteen cases with multiple rib fractures that underwent fracture fixation between 2014 and 2016 were included in the study. All of the cases were assessed with thoracic CT and radiologically. Patients diagnosed with flail chest following the physical examination and who had lung complications such as pneumothorax or hemothorax along with multiple displaced rib fractures, respiratory failure or toilet problems due to intensive pain and those who could not be mobilised due to pain were selected for surgical treatment and they underwent plate fixation of rib fractures. Screws and metal locked plates were used for the fixation according to the location of the facture and size of the rib. Fixation was not performed for posterior and subscapular fractures. Fourteen cases were evaluated according to the number of rib fractures, additional pathologies, number of fixations performed and length of stay in hospital.

Results

Eight of 14 patients were male, while six were female with an average age of 59.6 years (range: 29-76). The cause of injury in three cases was traffic accident with patient outside the car, in nine cases traffic accident with patient inside the car, in one case work accident and in one case falling down from height. Rib fractures were on the left in nine cases, on the right in two cases, and they were bilateral multiple in three cases. The average number of fractures was 7.5 costa (range: 3-16). All of the patients had other pathologies such as pneumothorax and hemothorax along with rib fractures. Ten out of 14 cases had flail chest. While two of the cases did not have additional pathology, they had vertebral and pelvis fractures. None of the cases underwent intubation and mechanic ventilation in the preoperative stage. Following the planning of their medical treatment based on their clinical condition, they underwent tube thoracotomy and rib fixation surgery was performed for all cases in an average of one day. Plate fixation was performed for all cases and the average number of plates used is 3.2 plates (range: 2-5). In a total of four cases, postoperative complications (Acute Respiratory Distress Syndrome (ARDS), pleural effusion, atelectasis, wound infection) were observed. The average length of stay in hospital in the postoperative period was 7.6 days (range: 3-14).

Discussion

Rib fractures due to blunt thoracic trauma occur with rate of 35-40% and 20-25% of the deaths due to trauma are caused by thoracic trauma [2]. Treatment for thoracic trauma is identified based on pain control and complications [1]. In multiple rib fractures dyspnea might occur due to intensive pain and an increase in pulmonary complications and atelectasis due to insufficient inspirium might be observed. This causes an increase in the length of stay in hospital, prolonged intensive care and increase in morbidity and hence increased cost [3]. Respiratory insufficiency, atelectasis due to insufficient clearing of secretions, pneumonia and empyema in flail chest cases are among the main reasons causing morbidity and mortality in blunt trauma cases [4,5].

Flail chest due to multiple rib fractures might cause respiratory distress. In addition to chest wall injuries, lung parenchyma is also common. In such cases of heavy thoracic trauma, the possibility of acute respiratory failure is more likely [6,7]. The first step in treatment of flail chest is ventilator support. Positive pressure ventilation could provide stabilization for the fractured segment of the rib while it could lead to lung complications such as pneumonia, empyema and barotrauma [6,8]. The most important aim of the treatment is to end the mechanical ventilation as soon as possible.

Mechanical ventilation was not used in any of the cases in the preoperative period. Among the reasons are listed below.

a) To prevent complications that could arise due to mechanical ventilation,

b) Even if there is an improvement in respiratory function in an average of 3-4 days ventilation period, ribs cannot be sufficiently stabilized in that period. Due to pain and insufficient mobilization following extubation, there is a risk of lung pathology, clinical improvement cannot be ensured and there might be a need for re-intubation.

c) There is a risk of hospital infections during the mechanical ventilation period as well as complications due to anaesthetics/sedative agents and stopping oral feeding.

d) Only one of the cases that underwent surgery for flail chest was intubated and connected to mechanical ventilator due to ARDS in the post-operative period. The case was followed up during 3 days of intubation. Nine cases with flail chest underwent surgery at an early period and hence were not connected to mechanical ventilator and they did not have complications caused by ventilator and long length of stay in the hospital. Compared to the standard approaches, the need for ventilator in these cases was 10%. The need arose not due to a complication during the pre-operative period but in the post-operative period.

Conservative treatment

Pain control is the first step in treatment of multiple rib fractures. Active pain restricts respiratory movements and cause hypoxia [7,9]. Narcotic analgesics and nonsteroid antiinflammatory agents are often insufficient in such cases and cause gradual decrease in respiratory movements and hence lung volume.

Fixation surgery approach for rib fractures continues to be debated in thoracic surgery literature. There are several reasons for that. Ends of the rib fractures are generally not displaced due to intercostal muscles and because they contact each other, they heal spontaneously. Secondly, ribs are not weight bearing bones. In case of acute respiratory failure due to multiple rib fractures, positive ventilation could be performed to expand the lung sufficiently. Rib fractures in the first three ribs usually do not lead to deformation in the chest wall thanks to muscles around the shoulders, pectoral muscles, clavicle bone and scapula. Therefore, rib fractures in this group do not necessarily require surgical repair. Since the twelfth rib is beneath the diaphragm and does not affect the integrity of the chest wall, it does not need fixation.

The other area where there is no need for surgery is vertebral and posterior rib fractures. Rib fractures in that area, which is surrounded with thick and strong paraspinal muscles, are less likely to have serious deformation. It is also an area with sufficient blood circulation enabling quick healing. Surgical approach in that part is also difficult due to paraspinal muscles. Considering all those factors, it is not possible to plan surgical treatment for all rib fractures.

Although our study is based on surgical approaches in rib fractures, we do not argue for surgical approach for all rib fractures. As it can be seen in more detail in the table 1, plates were not used for all fractures in the cases included in the study. The total number of fractures in 14 cases is 106 and plates were used in only 45 cases. All of the rib fractures that were stabilized through surgery are lateral and anterior rib fractures. A maximum of four ribs in the unilateral hemithorax were surgically treated.

There are some alternatives in conservative treatment including epidural catheter, oral-parenteral non-steroid anti-inflammatory medication, narcotic and sedative agents [10]. As we argued in another study with 513 cases with rib fractures, most of the rib fractures could be treated successfully with medical treatments and conservative approaches by applying treatments such as epidural catheter when necessary [2].

Surgical approach

Even if conservative treatment is the general approach in rib fractures, surgical treatment might be required in addition to medical treatment in cases of prolonged pain, bleeding, damage in parenchyma, poor posture and inadequate inspirium. Patients might continue to suffer from chest pain and have a reduced life quality due to deformed callus structure in displaced fractures left to heal spontaneously and deformed thoracic wall structure.

Studies arguing that medical treatment remain inadequate in treatment of rib fractures and it does not provide pain control and enable return to daily routine [11] demonstrate the need for surgical treatment option particularly for multiple rib fractures.

Table 1. Demographic characteristics of the patients

No	Age	Gender	Etiology	Thoracic pathology	Rib fracture	FC	Number of fractures	Additional trauma	Plated rib fractures	Number of plates	Complications	Hospital stay (days)
1	38	M	In car traffic accident	L hpx	L 6-8	-	3	V	L 6-8	3	-	3
2	72	F	Off-road traffic accident	L hx	L 1-6	-	6	P, Sc	L 4-6	3	-	4
3	72	M	Off-road traffic accident	L hpx	L 1-7	+	7	T, F	L 4,5	2	-	4
4	52	M	In car traffic accident	R hx	R 4-6	-	3	SAB	R 5,6	2	-	4
5	67	M	In car traffic accident	L px	L 2-8	+	7	St	L 3,4	2	-	5
6	46	F	In car traffic accident	R hx	R 2-9	+	8	-	R 6-8	3	Pleural effusion	5
7	65	F	In car traffic accident	L hpx	L 1-9	+	9	-	L 5-8	4	-	6
8	59	M	In car traffic accident	L hpx	L 3-9	+	7	V	L 6,7	2	Atelectasis	7
9	59	F	In car traffic accident	L hx	L 2-10	+	9	P, SAB	L 7-10	4	-	10
10	61	M	In car traffic accident	Bil. hx	L 3-8/R 6,9,10	+	9	V	L 6-8/ R9	4	-	10
11	76	F	Off-road traffic accident	L hpx	L 3-9	+	7	P	L 6-8	3	-	10
12	71	M	Falling	R hx, L hpx	R 3-9/L 5-8	+	11	Fem, P, Sc	R 5-8	4	-	11
13	29	M	Work accident	L px	L 3-7	-	4	Cl, Fem, T, Sc	L 3-6	4	ARDS	14
14	68	F	In car traffic accident	Bil. hx	R 2-10/L 4-10	+	16	V	R 8-10/L 8,9	5	Wound infection	14

Abbrev.: hpx: hemopneumothorax, hx: hemothorax, px: peunomothorax, FC: flail chest, V: vertebra, P: pelvis, Sc: scapula, T: tibia, F: fibula, SAB: subarachnoid bleeding, St: sternum, Fem: femur, Cl: clavicula

Clinical experiences of the majority of thoracic surgeons show that even in simple fractures with no complications, patients' quality of life decreases due to pain, they need medical treatment for a long period, and they suffer from workforce loss for a period of 3-4 weeks. Such conditions are worse especially in cases of multiple rib fractures. We believe that in addition to the cost of treatment, the cost caused by the loss of workforce due to various morbidities in the healing period should also be taken into account.

Rib fixation operations are mostly performed for complications such as prolonged drainage, presence of intrathoracic hematom and prolonged pain. Surgical indication for the flail chest treatment remains controversial. There are scholars who argue for surgical stabilization as well as those who argue for internal fixation by extending intubation period in cases of respiratory failure despite aggressive conservative treatment [12].

The area between 4th and 9th ribs forms the biggest part of the chest cavity and rib fractures in this area lead to significant deformity and hence failure in respiratory function. Flail chest most commonly occur in this area. Fractures in this area are more suitable for surgical stabilization because of the muscle types and as it is easier to manage.

Fractured ribs treated conservatively undergo progressive displacement, which results in volume loss in lungs and atelectasis. Early reduction and fixation of the fractured ribs restores the chest wall integrity, and forestalls the development of permanently damaging sequelae [13].

Stabilized thoracic wall decreases the need for mechanical ventilation thanks to adequate ventilation and tissue oxygenation [12,14]. Surgical stabilization of the chest wall have got advantages including decrease in the mechanical ventilation period, decrease in length of hospital stay, decreased period in intensive care unit and hence decrease in rates of respiratory function and posture deformation [3,15,16].

Additional factors such as the patient's age, cardiopulmonary state following the trauma and injuries in other organs need to be taken into account to select a suitable patient for rib stabilization.

According to a study, patients who were surgically stabilized had a significantly smoother course during the intensive care unit and hospital stays, decreased rate of impairment of pulmonary functions and decreased rate of complications, compared to the conservatively managed patients [13].

Hospital stay of the six cases out of 14 was more than 10 days. Considering the additional pathologies and post-operative complications, this is a reasonable period. The average number of rib fractures in eight cases who had less than 10 days of hospital stay is 6.2 days (range: 3-7). Clinical and radiological findings showed that they could be discharged in a maximum of one-week period and this shows the effect of the surgical approach.

Following the surgical stabilization, simple analgesic treatments enabled improvement in respiratory movements in the early period and mobilization. High average age of the cases and short length of stay in hospital despite their additional pathologies is striking.

In conclusion, we believe that open reduction and fixation in rib fractures is a method of treatment with significant benefits including increase the life quality of the patient, and decrease in potential complications, length of stay in the hospital and cost.

Declaration of conflicting interests

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Original Article

Prognostic factors and long-term survival outcomes of thymic tumors

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ABSTRACT

Background: Thymic masses are the most common anterior mediastinal neoplasms. In this study, we analyzed the histopathologic subgroups and stages of thymic tumors, evaluated mortality and morbidity, and identified the factors affecting survival in patients who underwent thymectomy due to thymic tumors.

Materials and Methods: 159 patients who underwent surgery in our center for anterior mediastinal mass between January 2005 and December 2016 were analyzed retrospectively. Of the patients who had thymectomy procedures, 76 with thymoma or thymic carcinoma were included in the study.

Results: The mean age of the patients was 51 ± 14.3 (18-77) years. Forty-seven patients (61.8%) were male, and 29 (38.2%) were female. Fourteen of the patients (18.4%) were aged 65 years or older. Sixteen patients (21.1%) also had myasthenia gravis. The diagnosis was thymoma in 67 patients (85.2%) and thymic carcinoma in 9 patients (11.8%). There were no statistically significant differences in survival outcomes based on Masaoka or World Health Organization (WHO) thymoma stage. In terms of the extent of resection, survival time was 83.4 ± 10.5 months for patients who had simple thymectomy and 124 ± 5.4 months among patients who underwent extended or maximal thymectomy ($p = 0.043$).

Conclusions: Our findings suggest that thymoma stage and histopathologic subgroup were not prognostic factors, while extended resection was the most significant factor in survival.

Key Words: thymoma, anterior mediastinal mass, thoracoscopic surgery, prognostic factors

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Introduction

Thymic tumors are rare tumors originating from thymic epithelial cells and are the most common neoplasm of the anterior mediastinal compartment. The incidence of thymoma was reported as 0.13 per 100,000 person-years in the United States [1]. Thymic tumors may be asymptomatic and detected incidentally or can cause symptoms related to mass effect or invasion of adjacent structures upon reaching a sufficient size. They may also present with symptoms associated with concomitant myasthenia gravis or other paraneoplastic conditions. Approximately 40% of patients with thymoma develop systemic paraneoplastic conditions [2].

Complete surgical resection is recommended for all thymic tumors due to their malignant potential. Thymic cells can also be detected microscopically in tissues adjacent to the thymus. The primary treatment for thymoma is surgical resection. Complete resection is a major prognostic factor affecting survival [3]. There is no clear consensus on surgical technique. Methods such as sternotomy, video-assisted thoracoscopic surgery (VATS), thoracotomy, and robotic surgery are used. Although there have been recent publications reporting the results of minimally invasive procedures in early-stage thymomas, the long-term outcomes have not been determined [2,3].

In the present study, we evaluated early and long-term morbidity and prognostic factors associated with survival in patients who underwent surgery for thymoma.

Materials and Methods

The records of 159 patients who underwent surgery for an anterior mediastinal mass in Yedikule Chest Diseases Hospital between January 2005 and December 2016 were analyzed retrospectively. A total of 76 patients were included in the study. The study was approved by the institutional review board and was conducted in accordance with the principles of the Declaration of Helsinki (version no: 1118, 09/11/2017). The flowchart of patient inclusion and exclusion is shown in Figure 1.

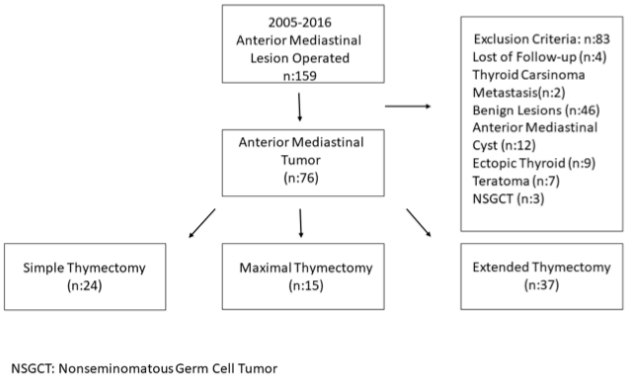

Figure 1. Flowchart of patient inclusion.

Preoperative Evaluation

All patients were evaluated for pulmonary function and cardiac pathology before surgery. Radiological evaluation was performed with chest x-ray and thoracic computed tomography (CT), and magnetic resonance imaging (MRI) and positron emission tomography–CT (PET/CT) was added to the preoperative examination when deemed necessary. All patients underwent routine preoperative biochemical analysis and electrocardiogram (ECG); echocardiogram (ECHO) was ordered when needed. All patients with suspected anterior mediastinal mass were evaluated for myasthenia gravis by a neurologist. Patients who were newly diagnosed with myasthenia gravis received medical therapy and underwent surgery after stabilization.

Comorbidities were categorized in four groups as respiratory (chronic obstructive pulmonary disease, asthma), cardiac (past myocardial infarction, arrhythmia, and history of the stent); endocrine (diabetes mellitus, goiter), and neurologic (myasthenia gravis).

Patients with no distant metastasis in the clinical and radiological evaluation and whose tumors were considered resectable underwent surgical resection. VATS, thoracotomy, or sternotomy was performed based on the radiologic location and size of the tumor and suspicion of invasion of adjacent tissues.

Surgical Approach

Simple thymectomy was defined as complete removal of only the mass and thymus by VATS, thoracotomy, or sternotomy.

Extended thymectomy was defined as resection of the thymus together with the surrounding pericardial/diaphragmatic adipose tissues to the bilateral phrenic nerve in the horizontal axis and the area from the thyroid to the diaphragm in the axial axis by VATS, thoracotomy, or sternotomy (Figure 2).

Figure 2. Material resected in extended thymectomy.

Maximal thymectomy was defined as extended thymectomy via sternotomy with the additional dissection of the cervical, paratracheal, subcarinal, and aorticopulmonary lymph nodes.

Any detected invasion of the pericardium, parenchyma, pleura, or vasculature was included completely within the surgical margins.

Postoperative Follow-up

Based on the histopathological diagnosis, the patients were separated into two main groups, thymoma, and thymic carcinoma. Thymoma staging was done according to the World Health Organization (WHO) [4] and Masaoka [5] staging systems. Of the recorded complications, we evaluated morbidities that occurred in-hospital or within the first postoperative month. Atelectasis, hemorrhage, pneumonia, atrial fibrillation managed with medical treatment, surgical site infections requiring revision, and hoarseness were accepted as morbidities.

The groups were further classified by histopathologic subgroup and stage. Mortality, morbidity, and factors believed to be associated with survival were analyzed.

Statistical Analysis

The SPSS version 22.0 (SPSS Inc., Chicago, IL, USA) software package was used for statistical analyses. As descriptive statistics, the Chi-square ($\chi 2$) test was used to calculate frequency values. A t-test was used to compare means of independent groups and the Mann-Whitney U test was used to compare medians. Survival analysis was conducted using the Kaplan-Meier method and curves were compared using the log-rank test. Prognostic factors were analyzed with multivariate analysis using Cox's proportional hazard model to adjust for potential confounding factors. The statistical significance level was accepted as $p = 0.05$ for all analyses.

Results

Of the 76 patients included in the study, 47 (61.8%) were male, and 29 (38.2%) were female. The mean age was 50 ± 13.8 (18-81) years. Fourteen of the patients (18.4%) were aged 65 years or older. Sixteen patients (21.1%) were also diagnosed with myasthenia gravis. There were 45 smokers in the patient group (59.2%). Thirty-four (44.7%) of the 76 patients included in the study had comorbid diseases, the most common of which were myasthenia gravis and cardiac comorbidities. The patients' demographic data are summarized in Table 1.

Table 1. Demographic characteristic of patients with thymic tumors.

Variables		(n)	%
Gender	Male	47	61.8
	Female	29	38.2
Age (year)		50.9±13.8	
Age	<65	42	81.6
	>65	14	18.4
Smoke (package/year)		12.40±16.3	
Smoke	Yes	45	59.2
	No	31	40.8
Comorbidity	Myasthenia	16	21.1
	Cardiac	16	21.1
	Endocrinological	14	18.4
	Pulmonary	3	3.9
Myasthenia Gravis	Yes	16	21.1
	No	60	78.9

Six patients (7.9%) with a suspected invasion of major vascular structures were given neoadjuvant radiotherapy. All 6 of these patients underwent sternotomy after neoadjuvant therapy, and complete resection was achieved. Fifty-eight patients (76.3%) underwent sternotomy, 8 (10.5%) underwent VATS, and 10 (13.2%) underwent thoracotomy. Comparison of tumor size according to surgical approach showed that mean tumor

diameter was 28.8 ± 3.9 (10-48) mm in patients selected for VATS, 69.2 ± 15.9 (0.1-150) mm in those selected for sternotomy, and 66.8 ± 4.1 (10-175) mm among those selected for thoracotomy (p = 0.003).

Twenty-four (31.6%) of the patients underwent simple thymectomy, 37 (48.7%) underwent extended thymectomy, and the remaining 15 patients (19.7%) underwent maximal thymectomy. In addition to thymectomy, lung parenchymal wedge resection was performed in 7 patients, left upper lobectomy in 1 patient, left innominate vein graft in 1 patient, and superior vena cava resection in 1 patient. The mean length of hospital stay was 6.4 ± 6.4 (2-45) days. The surgical approach was not associated with length of hospital stay (p = 0.057).

Postoperatively, 33 complications occurred in 25 (32.9%) of the 76 patients. No significant difference in complication rates was observed according to age, sex, surgical approach (VATS, thoracotomy, sternotomy) or extent of resection (simple, extended, maximal) (p > 0.05). Atelectasis occurred in nine patients, hemorrhage requiring revision in 1 patient, pneumonia in 4 patients, medically managed atrial fibrillation in 7 patients, deep surgical site infection in 7 patients, persistent hoarseness in 1 patient, and diaphragmatic eventration due to phrenic nerve injury in 4 patients.

A statistically significant difference in complication rate was detected between patients with and without comorbidities (17 patients vs. eight patients, respectively; p = 0.05). When the relationship between myasthenia gravis and postoperative complications was examined, it was seen that 8 (50%) of 16 patients with myasthenia gravis developed complications (p = 0.099). Of the 14 patients with endocrine comorbidities (diabetes, hypothyroidism), eight (57.1%) developed postoperative complications (p = 0.04). Length of hospital stay was significantly longer in patients who developed complications (p < 0.001) (Table 2).

Table 2. Evaluation of factors affecting the morbidity.

Variables		Morbidity (None) n (%)	Morbidity (Yes) n (%)	P
Age (Year)		49.33±13.05	54.24±15.10	0.201
Age	<65	46 (74.2)	16 (25.8)	0.010
	>65	5 (35.7)	9 (64.3)	
Gender	Male	33 (64,7)	14 (56)	0.313
	Female	18 (35.3)	11 (44)	
Smoke	No	21 (41.2)	10 (40)	0.562
	Yes	30 (58.8)	15 (60)	
Comorbidity	No	34 (66.7)	8 (32)	0.004
	Yes	17 (33)	17 (68)	
Surgical approch	VATS	4 (7.8)	4 (16)	0.174
	Sternotomy	38 (74.5)	20 (80)	
	Thora-cotomy	9 (17.6)	1 (4)	
Resection	Simple	17 (70.8)	7 (29.2)	0.168
	Extended	27 (73)	10 (27)	
	Maximal	7 (46.7)	25 (53.3)	

Abbrev.:VATS: Video-Assisted Thoracoscopic Surgery

When divided based on histopathology, 67 (85.2%) of the patients had a thymoma, and 9 (11.8%) had thymic carcinoma. All subgroups based on thymic tumor stage are shown in Table 3.

Table 3. Masaoka staging and WHO classification of patients with thymoma.

Masaoka staging	(n)	%
1	34	44.7
2a	14	18.4
2b	18	23.7
3	10	13.2
WHO classification		
A	13	17.1
AB	17	22.4
B1	10	13.2
B2	11	14.5
B3	9	11.8
B1+B2	3	3.9
B2+B3	4	5.3
Thymic carcinoma	9	11.8

There was no intraoperative mortality in this series. The 30-day mortality rate was 1.3% (n = 1) and the 3-month mortality rate was 2.6% (n = 2). All three of the deceased patients underwent sternotomy; one was lost in the first postoperative month due to a myasthenic

crisis. Another patient died due to respiratory failure after pneumonia, and the other was diagnosed with myasthenia gravis and died due to other problems.

11 (45.8%) of the patients who underwent simple thymectomy according to Masaoka stages were stage 1, 10 (41.7%) were stage 2, and 3 (12.5%) were stage 3. Masoka stages of the patients who underwent extended or maximal thymectomy were 23 patients (44.2%) stage 1, 22 patients (42.3%) were stage 2, seven patients (13.2%) were stage 3. There was no statistically significant difference between these groups (p = 0.989).

The mean follow-up time was 62.6 ± 34.1 months. Mean overall survival was 118 ± 5.5 months. The 5-year survival rate was 83.3%, and 10-year survival was 79.4%. Advanced age and extent of resection were identified as prognostic factors affecting survival (Table 4) (Figure 3).

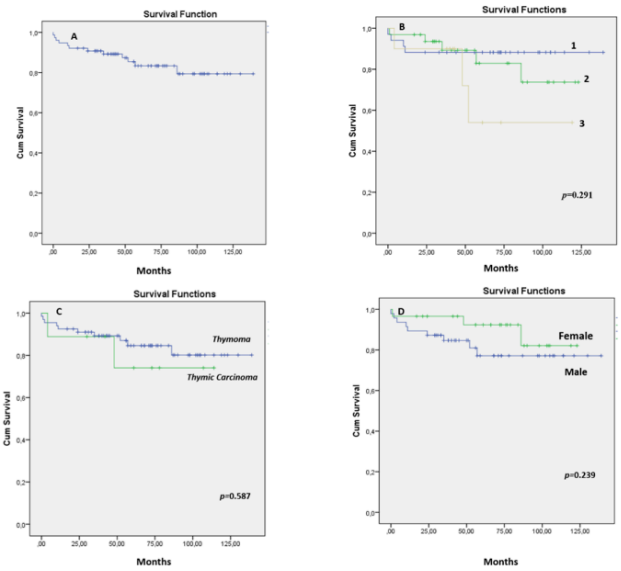

Figure 3. Kaplan–Meier survival curve according to Overall Survival **(a)**, Kaplan–Meier survival curve according to Masaoka **(b)** staging, Kaplan–Meier survival curve according to the histopathological staging **(c)**, Kaplan–Meier survival curve according to the gender **(d).**

Table 4. Prognostic factors affecting the survival of patients with thymic tumors.

Variables		Mean	%95 CI	5 Year OS%	10 Year OS %	P
Gender	Male	113±7.6	98-128	77.1	77.1	0.239
	Female	111±6	100-123	92.4	82.1	
Age	<65	124±5.0	114-134	89.0	84.7	0.002
	>65	56±9.7	37-75	53.9	-	
Resection Type	Simple	83±10.5	62-104	83.3	62.5	0.043
	Extended/ Maximal	124±5.4	113-135	89.5	85	
MG	No	121±5.7	110-132	89.0	83.7	0.263
	Yes	93±12.2	70-117	81.3	60.9	
Masaoka	1	123±7.3	108-137	88.2	88.2	0.291
	2	104±7.3	90-119	82.9	73.7	
	3	82±15.9	51-113	54	54	
Histopathology	Thymoma	119±5.7	107-130	80	80	0.587
	Thymic carcinoma	92±13.6	65-118	74	74	
Adjuvant therapy	No	117±7.09	103-130	85	80.7	0.829
	Yes	81±3.85	73-88	78.8	-	

Abbrev.:OS: Overall Survival, MG: Myasthenia Gravis, CI: Confidence Interval

Recurrence occurred in three patients (3.9%), of whom 2 had thymic carcinoma, and 1 had type B3 thymoma. There was a significant association between histopathologic stage and recurrence (p = 0.03). Survival analysis, according to the extent of resection, showed that mean survival time was 83.4 ± 10.5 months in the simple thymectomy group and 124 ± 5.4 months in the other groups (extended and maximal thymectomy) (p = 0.043).

Discussion

Determining the actual incidence of anterior mediastinal masses from the medical literature can be difficult for several reasons. One of these is the varying clinical and radiological classifications used to define the mediastinal compartments. Another reason is that non-neoplastic lesions such as thymic cyst and pericardial cyst are included in these numbers. Despite the difficulty of

determining their exact incidence, approximately 35% of anterior mediastinal lesions are thymic malignancies [6-8]. Among the total patient population screened for inclusion in this study, the incidence of thymic epithelial malignancy was 76 in 159 patients (47.7%).

Thymoma is reported to affect both sexes equally and usually appears in the fourth or fifth decades [9]. In our patient group, 61.9% were men, and the mean age was 50 ± 13.8 (18-81) years, consistent with the literature.

Surgery is the cornerstone of thymoma treatment, being the only curative method. The goal is to achieve complete surgical resection, which requires resection of possible tumor spread outside the thymus. Partial or full sternotomy for complete thymectomy is the main surgical approach in thymus surgery. For advanced tumors, additional incisions should be used when necessary to achieve complete resection, especially in the presence of lung or pleural space invasion. Some investigators reported no local recurrence in patients without microscopic invasion of the capsule and surrounding tissues, while others have reported local recurrence at rates of 2–10%. Thymomas can be invasive and metastatic. Therefore, surgical procedures should be planned, taking into account the malignant potential of all thymomas [10]. In our study, the rate of local recurrence was 3.9%. Two of the local recurrences were thymic carcinoma, and one was type B3 thymoma.

Procedures and standards of minimally invasive methods were defined by the International Thymic Malignancy Interest Group (ITMIG) in 2011 to facilitate systematic data collection [11]. Minimally invasive thymus resections were already being performed in our center and were adapted to conform to this new framework of standards following the ITMIG workshops. In our clinic, we perform extended thymectomy by VATS in patients with tumors that are 3 cm in size, stage 1-2, and assessed as resectable using VATS. The feasibility of extended thymectomy via VATS has been debated, and the concept of videothoracoscopic extended thymectomy has been described. We believe that inexperienced centers, VATS thymectomy is appropriate for thymomas up to 3 cm in size provided that complete resection is achieved.

The coexistence of specific autoimmune diseases with thymoma, especially myasthenia gravis, must be evaluated before surgery. The incidence of thymoma in patients with myasthenia gravis is known to be 10–15%, while approximately 30% of patients with thymoma are reported to have myasthenia gravis [12]. Some publications report that myasthenia gravis in patients with thymoma is associated with a poorer prognosis, while others have reported that prognosis is not adversely affected. In a multicenter study of 1089 patients, Kondo and Monden reported that thymomas associated with myasthenia gravis were diagnosed earlier and had a lower rate of recurrence due to their less aggressive nature; therefore, they claimed that the presence of myasthenia gravis could be considered a favorable prognostic factor for thymoma [13-15]. Of all the thymoma patients in our series, 16 (21.1%) were diagnosed with myasthenia gravis. The 5- and 10-year survival rates of patients with myasthenia gravis were 81.3% and 60.9% ($p = 0.263$).

The most significant prognostic factor in thymoma is complete resection. Another prognostic factor accepted by many researchers is the quality of the surgery [15]. In a study by Cowen et al. [16], the metastatic spread was significantly more common among patients who did not undergo complete surgical treatment (had an only biopsy or subtotal resection) when compared with patients who underwent complete resection. A complete resection rate of 100% was reported in patients with stage I thymoma, and this success rate was found to decrease as stage increased [17]. According to Detterbeck et al. [18], complete resection results in significant improvement in survival for patients with stage III tumors in particular. In the present study, we observed no significant difference in survival based on Masaoka staging ($p = 0.291$). However, there was a trend toward poorer survival outcomes as the stage increased. We attribute the discrepancy between our findings and those reported in the literature to our small patient number. Advanced age and extent of resection were identified as factors associated with survival in our study.

In addition to thymoma staging, histopathology can also be useful in determining tumor resectability. Nearly all WHO type A thymomas are noninvasive tumors and

should be treated with complete resection. Type B thymomas are often invasive, and the timing of the presentation is very important. Effort should be made to resect as completely as possible. Although complete resection is achieved in 92% of these tumors, recurrence has been reported at a rate of 29% [19]. In the present study, recurrence was observed in a total of 3 patients (3.9%), 2 with thymic carcinoma, and 1 with type B3 thymoma ($p = 0.03$). All three of these patients had stage III disease. We detected a close association between histopathological stage and the likelihood of recurrence. As with Masaoka stage, there was no significant difference in survival between the histological subgroups of thymomas compared to thymic carcinomas according to WHO stage ($p = 0.587$).

There were no statistically significant differences in survival outcomes based on Masaoka or WHO thymoma stage. In terms of the extent of resection, survival time was 83.4 ± 10.5 months in the simple thymectomy group versus 124 ± 5.4 months in the combined extended and maximal thymectomy group ($p = 0.043$). Based on this finding, we believe that regardless of stage or histopathologic subtype, complete resection of thymomas with at least extended resection is a key factor in survival.

The main limitations of our study were that it included a small number of patients, multiple surgeons performed the procedures, and the general status of the patients was not assessed preoperatively. In addition, we were not able to demonstrate a statistically significant effect of thymic carcinoma histopathologic subgroup and survival. A large number of subgroups resulted in insufficient patient numbers in each group.

As a conclusion, although not significant, the tumor stage was found to be a poor prognostic factor, while complete resection and advanced age were the most significant prognostic factors identified in our study. All of the patients in our study underwent complete resection, and survival outcomes were acceptable, independent of stage and histopathological features. However, patients who underwent simple thymectomy had significantly lower survival rates despite a complete resection. This suggests that regardless of stage or histopathologic subtype, complete resection of thymomas with at least extended resection is a key factor in survival.

Declaration of conflicting interests

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Case Report

How to remove giant mediastinal goiter from left to right?

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ABSTRACT

We present a 57-year-old woman who has a giant mediastinal goiter, which lies down from cervical zone to right posterior mediastinum. On physical examination mediastinal goiter was nonpalpable. Giant mediastinal goiter was removed by right lateral thoracotomy, cervical collar incision and partial sternotomy. Pathology was reported as a multinodular goiter. We cannot perform VATS (video-assisted thoracoscopy) due to tight adhesion of the pleura. With the difference of literature partial sternotomy can be added to the transcervical and lateral thoracotomy approach for ease of removing giant posterior mediastinal goiters which lie down left cervical to the right posterior mediastinum.

Key Words: partial sternotomy, posterior mediastinal goiter, thoracotomy, transcervical approach

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Introduction

Mediastinal goiters are grouped under two main headings which primary and secondary. Primary goiters root in an abnormal embryologic migration of the thyroid anlage. Secondary goiters develop from the descent of the thyroid into the mediastinum. Primary mediastinal goiter's blood supply is from the mediastinal vessels in spite of this secondary mediastinal goiter's blood supply from the cervical branch of arteria thyroidea. In the literature, the incidence of substernal goiter is reported between 0.2-45%. Primary mediastinal goiters are quite rare, occurring in less than 1% of all goiters. Secondary mediastinal goiters most commonly grow to anterior mediastinum, just 10-15% of these grow to posterior mediastinum [1].

In this case report, we presented a quite rare giant posterior secondary mediastinal goiter, which lies down left cervical to the right posterior mediastinum and its surgical management.

Case Report

A 57-year-old woman presented with dyspnea and dysphagia. On physical examination, there wasn't any palpable mass on her anterior neck. Thyroid ultrasonography showed that her both thyroid lobes had multiple, variable magnitude and hypoechoic /isoechoic solid nodules. The chest x-ray revealed a homogeneous opacity projecting on the right upper mediastinum. Computed tomography (CT) of the thorax demonstrated a large multinodular goiter, which enlisted in the upper mediastinum laminating the trachea and esophagus and displacing them to the anterior. It was in tight contact with the aortic arch and its left lower pole down into the posterior mediastinum and arrives below the carina (Figures 1a,b).

Ultrasonography-guided fine needle aspiration biopsy showed a multinodular colloid goiter. The patient consented for total thyroidectomy through a transcervical approach, and if necessary, transthoracic approach by both general and thoracic surgery teams. At first, a thyroidectomy was begun via a standard cervical approach. We could not perform VATS (video-assisted thoracoscopic surgery) due to tight adhesion of the pleura. Then we performed right lateral thoracotomy and partial sternotomy (Figures 1c,d).

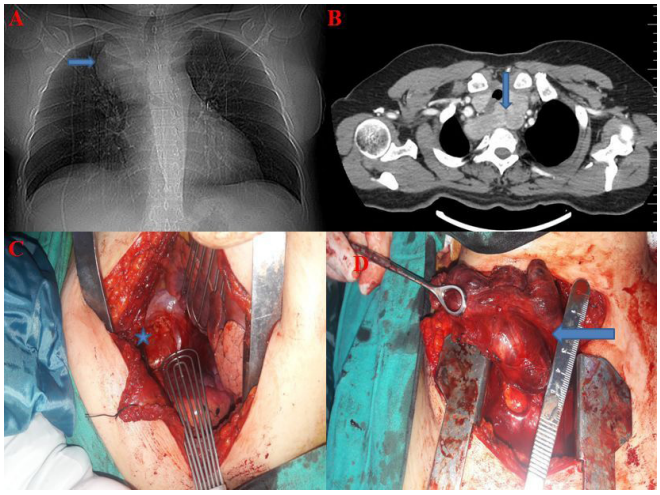

Figure 1. The posteroanterior chest x-ray shows the lesion extending to the upper right mediastinum **(a)**, the computed tomography of the thorax shows the goiter extending from the left cervical region to the right upper mediastinum **(b)**, the image of the goiter released from the mediastinum with right lateral thoracotomy (the star shows the mediastinal mass) **(c)**, the excision of the mass by partial sternotomy (the arrow shows the macroscopic view of the mediastinal mass) **(d).**

A lateral thoracotomy was performed to release the mass lesion from the thorax and a partial sternotomy incision was added to remove the mass from the neck incision. After excision of the goiter, we found that the right lobe was measured 6x4.5x3 cm, left lobe with mediastinal part was measured 13x10x4 cm (Figure 2).

Figure 2. Macroscopic image of the excised goiter.

The patient was discharged at day 5. Histopathological examination reported a multinodular goiter. Fifteen months after surgery, the patient was asymptomatic and disease free.

Discussion

Most substernal goiters can be accessed via the collar incision but 2-29% requires additional incisions. These incisions can be lateral thoracotomy, partial or total sternotomy dependent on the placement of mediastinal goiters.

Symptoms of secondary mediastinal goiters are dysphagia, dyspnea, and mass on the neck. Our patient did not have any mass on her neck but she had both dysphagia and dyspnea [2].

Computed tomography of the neck CT and are used for imaging. CT of the thorax provides information pointing toward the between anatomical structures and thyroid nature of the mediastinal mass [3]. Secondary mediastinal goiters lie down from cervical zone to the upper mediastinum and 50% of the lesion is under the aperture thoracica superior. These masses usually come by trachea and lie down to anterior mediastinum. Ten to fifteen percent of these extend to the right side of posterior mediastinum [4].

Negative thoracic pressure, gravity and the potential space in the thoracic cavity cause goiters to extend to the thoracic cavity. The posterior mediastinal extension is usually right-sided because of the presence of the aortic arch and pulmonary vessels on the left side obstructing the path of descent [5]. Machoda et al. reported that giant mediastinal goiters, which excised from left to right via the transcervical and lateral thoracotomy [4]. On the literature, there are some methods including VATS and RATS (robotic-assisted thoracoscopic surgery) [3].

In our case, the lesion was extremely big so that at first we started via VATS but we couldn't perform VATS due to tight adhesion of the pleura because of this we added partial sternotomy to our operation approach for removing the mass easily.

This incision did not cause any complication but also made removing the giant flipped goiter easy.

In conclusion, we can add partial sternotomy to transcervical plus lateral thoracotomy approach to remove a giant multinodular goiter easily, which lies down from cervical zone to right posterior mediastinum.

Declaration of conflicting interests

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Case Report

Mass lesion in the neighborhood of the rib and vertebra: extramedullary hematopoiesis

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ABSTRACT

Extramedullary hematopoiesis is the production of blood outside of the bone marrow. While it may normally arise in the liver and spleen during the fetal period, it is considered as a compensatory mechanism in adults. Extramedullary hematopoiesis is seen in patients with chronic anemia such as thalassemia, hereditary spherocytosis, most commonly in the liver and spleen, as in the fetal period. On the other hand, intrathoracic hematopoiesis is quite rare. The aim of this study is to discuss this rare condition.

A 42-year-old male patient was examined for a mass incidentally detected in the lung during his routine follow-ups. In our patient with no history of diseases except for external thalassemia intermedia, the scattered homogeneous density increments on the posteroanterior chest x-ray were evaluated and his thoracic tomography revealed soft-tissue increments of 7.5 cm in the vicinity of the rib and vertebrae. Extramedullary hematopoiesis should be kept in mind in the differential diagnosis of patients with bilateral masses by the contiguity of the rib and vertebrae. Hematological studies should be conducted in this regard.

Key Words: extramedullary hematopoiesis, thalassemia intermedia, posterior mediastinal mass

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Introduction

Extramedullary hematopoiesis (EMH) is defined as the production of blood cells outside the medulla and is normally seen in the liver and spleen during the fetal period [1,2]. On the other hand, EMH also arises in myeloproliferative diseases or hematological diseases, such as hemolytic anemia in adults.However, the mechanism at the molecular level is not fully known [3]. EMH most commonly arises in the liver and spleen, but it may also be rarely seen in the mediastinum, lymph nodes, breast, and central nervous system. In mediastinum, it is mostly located in the posterior mediastinum [3].

Case Report

Three years ago, a 42-year old patient with no complaint was referred to Erciyes University, Department of Thoracic Surgery due to multiple homogeneous density increases on posterior-anterior chest x-ray, which had been performed for follow-up. It was learnt from the history that the patient, who was followed up by the Department of Haematology with the diagnosis of thalassemia intermedia and needed erythrocyte suspension once in every 3-4 months, underwent splenectomy in another center 20 years ago. His complete physical examination revealed no additional systemic pathology except for conjunctival pallor and his laboratory test results were as follows; Hgb: 8.7gr/dL, WBC: 10.610/mm3; Plt: 358.000/mm3. His PA chest x-ray showed multiple homogeneous density increments that did not obliterate the cardiac contours (Figure 1).

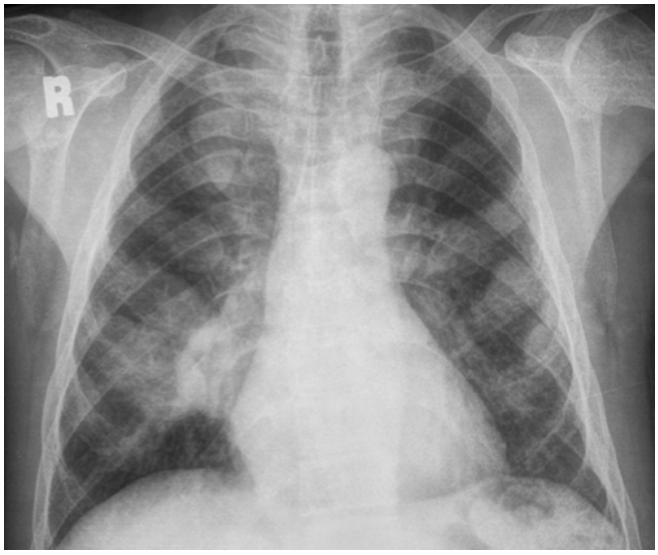

Figure 1. PA chest x-ray showing multiple homogeneous density increments and not obliterating the cardiac contours.

The computed tomography of the thorax showed bilateral irregular soft tissue mass around the rib and adjacent to the vertebrae. The density of the liver was visualized to be diffusely increased and the spleen was not visualized on tomography due to splenectomy (Figure 2).

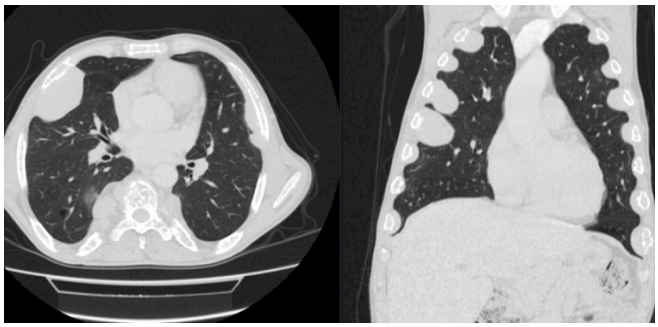

Figure 2. The density of the liver was visualized to be diffusely increased and the spleen was not visualized on CT due to splenectomy.

The mass lesions in the thorax were first interpreted in favor of EMH in consultation with hematology and radiology because of the diagnosis of thalassemia. Complications that may arise during the diagnostic procedure were discussed and the patient was informed and no histopathological confirmation was done. The patient was followed up for 3 years without any active complaints and no significant change was observed during the radiological follow-up examinations (Figure 3).

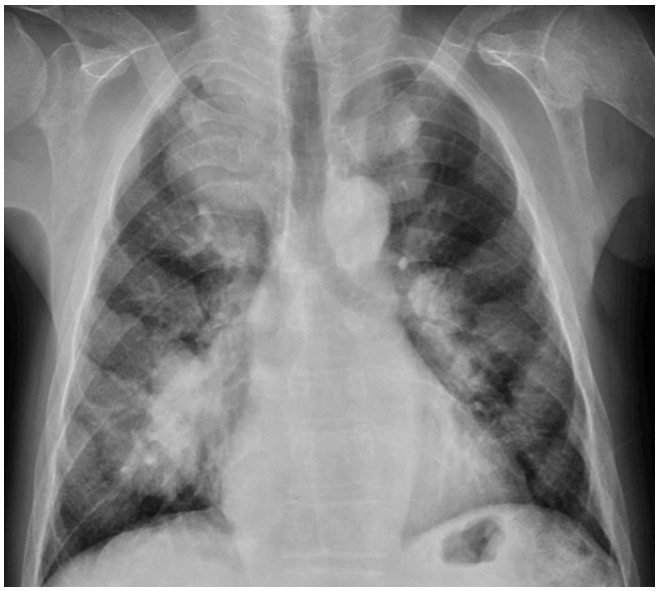

Figure 3. The patient was followed up for 3 years without any active complaints and no significant change was observed during the radiological follow-up examinations as shown on PA chest x-ray.

Discussion

Extramedullary hematopoiesis is a compensatory mechanism that usually occurs in the case of chronic anemia. Therefore, it is seen in diseases with chronic anemia. It has been reported that EMH is most frequently associated with thalassemia among these diseases [2]. In this case report, the patient had thalassemia intermedia disease, which caused chronic anemia.

EMH foci usually remain at a microscopic level and rarely reach a mass size. In terms of incidence, the most common locations of these foci are liver, spleen and mediastinum. These foci show up as symmetric masses when situated in the thorax [5]. Our patient had a history of splenectomy and his liver density was diffusely increased. He had masses in the posterior mediastinum and adjacent to the rib margins.

Most of the time, patients are incidentally diagnosed unless there is a symptom associated with the masses [6]. The diagnosis is usually made by the coexistence of a symmetrical, uniformly demarcated, lobulated, homogeneous mass on CT or MRI, and chronic anemia [1,5-7]. When EMH is situated in the posterior mediastinum, it may be confused with other mediastinal masses.

No diagnostic procedure is recommended since the lesion is prone to bleed [1,4-6]. However, VATS is recommended instead of needle biopsy due to effective bleeding control when the diagnosis is uncertain [6]. The diagnosis in patients with EMH located in the thorax can be made with the presence of symmetric masses along with chronic anemia or a disease leading to anemia. In our presented case, the patient was informed without performing any diagnostic procedure because of the diagnosis of underlying thalassemia intermedia and the presence of symmetrically located masses on the thoracic imaging.

The treatment was planned based on the size and location of the masses and the severity of the symptoms. On the other hand, non-symptomatic patients are followed up without treatment. Meanwhile, there is no standard treatment option. Blood transfusions, radiotherapy, use of fetal hemoglobin, hydroxyurea, and in rare cases, surgery or combination of these may be preferred for the treatment [2,4]. In this case report, the treatment of erythrocyte suspension transfusion was chosen and no growth or complication was observed in the EMH foci located in the thorax for 2 years.

In conclusion, patients with posterior mediastinal or pleural-based masses should be questioned whether there is a symmetrical distribution of the lesions before planning a diagnostic or therapeutic procedure and whether there is a hematological disease such as thalassemia with chronic anemia in the medical history by checking routine hematological parameters. By this means, an incorrect intervention can be prevented in patients with extramedullary hematopoiesis for whom interventional procedures for treatment and even diagnosis are avoided.

Declaration of conflicting interests

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Case Report

Rare mediastinal complications of dental procedures

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ABSTRACT

Dental extraction is a frequently performed procedure in daily routine. Although this procedure is associated with a low complication rate, it has the potential to cause lethal complications such as head and neck emphysema, pneumomediastinum, pharyngeal abscess, septic thrombophlebitis of internal jugular vein, descending necrotizing mediastinitis, peribronchovascular inflammation of the lung parenchyma, and septicaemia. Conservative management is sufficient in majority of patients with emphysema and/or pneumomediastinum. However, treatment of pharyngeal abscess, mediastinitis and mediastinal abscess cannot be achieved with solely antibiotic administration and surgical drainage is necessary in most of the cases. In this report, we present three cases; two cases of pneumomediastinum and one case with severe deep neck inflammation, thrombophlebitis of jugular vein, mediastinitis and empyema occurred following molar tooth extraction by using air-tribune drills. Two cases without infectious complications were treated conservatively while the other patient was treated surgically. Complete resolution was achieved in all patients during follow-up.

Key Words: dental extraction, pneumomediastinum, mediastinitis

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Introduction

Dental extraction is a frequent procedure that has the potential to cause lethal complications if not performed under appropriate conditions. Complications encountered after dental extraction range in a variety of disorders including head and neck emphysema, pneumomediastinum, pharyngeal abscess, septic thrombophlebitis of internal jugular vein, mediastinitis and mediastinal abscess, peribronchovascular inflammation in the lung parenchyma, and septicemia [1-4]. Pneumomediastinum, which is defined as entrapment of free air in the mediastinal space, was first described by Laënnec in 1819 [5]. The occurrence of pneumomediastinum and subcutaneous emphysema due to dental treatments is very rare. The usage of high-speed air-tribune drills can lead to the introduction of air into soft tissues and has been reported as the most common cause of this complication [6-8]. Oral flora may also spread to the neck through the cervical fascia and cause deep neck infection or descending necrotizing mediastinitis (DNM) [3,9]. Herein, we report two cases of pneumomediastinum and one case with severe deep neck inflammation, thrombophlebitis of jugular vein, mediastinitis and empyema occurred following molar tooth extraction by using air-tribune drills.

Case Reports

Case 1:

A 30-year-old woman was admitted to our emergency department with a swollen neck, 2 h after she had undergone root canal restoration of the third right mandibular molar with an air-tribune drill, which inflates air in the root canal. Her physical examination revealed neck swelling with crepitation on both sides. Chest x-ray showed subcutaneous emphysema of the laterocervical and presternal regions (arrows) (Figure 1a). Computed tomography (CT) of the neck and chest demonstrated air entrapment at the submaxillary and retromandibular spaces, extending through superior mediastinum (arrows) (Figure 1b).

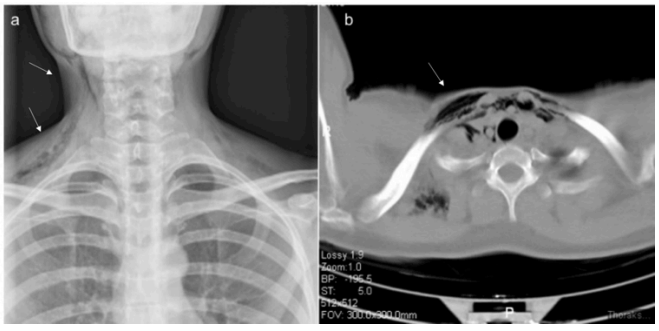

Figure 1. Chest x-ray showing the subcutaneous emphysema **(a)** and computed tomography image **(b)** showing the air entrapped in the superior mediastinum.

Prophylactic antibiotic and analgesia were administered. The patient had an uneventful recovery and was discharged after 4 days without any sequelae.

Case 2:

A 31-year-old woman presented in our emergency department with mild dyspnea and right-sided neck swelling, 4 h after right third molar surgical extraction. A high-speed air turbine drill was used during the procedure. Physical examination showed right-sided facial and neck swelling and crepitation on palpation. All vital signs were stable. CT of the neck and thorax demonstrated air in the subcutaneous and visceral spaces in the right mandibular area, spreading through right maxillary sinus to orbital region and superior mediastinum (arrows) (Figure 2).

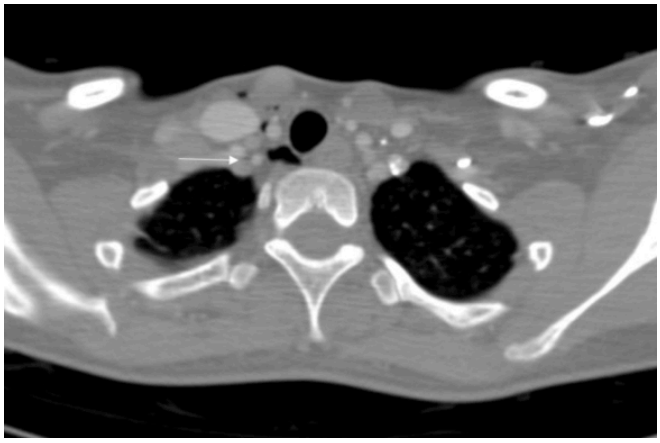

Figure 2. CT image showing air entrapped in the superior mediastinum.

The patient was admitted to the Thoracic Surgery Department unit for spontaneous air resorption. Antibiotic prophylaxis with amoxicillin-clavulanic acid was administered. She had an uneventful recovery and was discharged after 3 days. She attended a follow-up visit in two weeks later, confirming complete resolution of the process.

Case 3:

A 54-year-old male patient was admitted to our emergency department three days after molar teeth extraction. He had fever, limited mouth and neck movements, neck swelling, shortness of breath and difficulty swallowing. Physical examination revealed poor oral hygiene, swelling, redness and crepitation in the right supraclavicular region. He also had a history of diabetes mellitus. CT examination demonstrated subcutaneous emphysema in right submandibular and submental regions and inflammatory stranding in fat tissues of deep neck region and

superior mediastinum suggesting deep neck infection spreading to mediastinum. Management of the patient was discussed with the ENT (Ear, nose, throat) surgeons. Medical treatment with antibiotherapy and early follow-up CT was planned. Fourth day follow-up CT revealed increased severity and extension of inflammation and additional submandibular abscess, thrombophlebitis of right internal jugular vein, mediastinitis, mediastinal abscess, peribronchovascular thickening in right parahilar region and right-sided empyema (Figure 3).

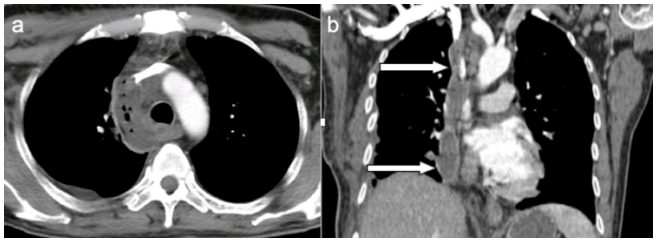

Figure 3. Axial **(a)** and coronal **(b)** contrast enhanced CT images showing a mediastinal abscess (arrow) at the right paratracheal area in superior mediastinum extending through mediastinum to the right hemidiaphragm.

Blood culture yielded Streptococcus anginosus. Surgical intervention was planned as interventional drainage was not considered by the Interventional Radiology Department. Single-port Video Assisted-Thoracoscopic Surgery (VATS) was performed. Cervical mediastinal pleura was swollen and edematous. Cervical mediastinal pleura was opened from the uppermost level of the swollen tissue and the abscess was drained. There was no purulent drainage from the chest tube during the post-operative period. Follow-up CT imaging showed shrinkage of the neck abscess and mediastinal infection with persistence of the right internal jugular vein thrombophlebitis. The post-operative course of the patient was uneventful. The patient was symptom free at 1st month follow-up.

Discussion

The appearance of subcutaneous emphysema and pneumomediastinum can be secondary to trauma, infections, maxillofacial operations, and dental surgery. In general, the condition is self-limiting and not life threatening, but rarely it can progress to tension pneumothorax, mediastinitis or gas embolism [6,10]. The use of high-speed dental air turbine drills can lead to the introduction of air or water into soft tissue spaces through the dentoalveolar membrane in the root canal. Third molar tooth extraction in which the tooth was sectioned using an air- turbine drill was observed as the most frequent cause, which was also seen in our second case [8,11]. Occasionally, it may also arise during restorative treatment, root canal treatment, periodontic surgery, scaling, laser irradiation, and even flashing of the air syringe, as seen in case one [12].

Fascial spaces around the cervical fascias are not real spaces. They contain small amounts of loose connective tissues. During dental procedures, compressed air may enter from the tooth roots to the submandibular space and dissects through the cervical fascial planes and gradually extends between these spaces. After accessing to lateral pharyngeal and retropharyngeal spaces, air can easily spread to the mediastinal cavity. Thus, these spaces should be considered as potential pathways for the spread of air, fluid and any microorganism [8,13,14]. The cause of infections is oral flora containing both aerobic and anaerobic microorganisms, which may cause life-threatening complications in the setting of immunosuppression. The presence of diabetes mellitus in our patient may be an underlying cause for spreading of infection along the neck and mediastinal soft tissues resulting in DNM [15]. Although we consider administering immediate prophylactic antibiotherapy to all patients to avoid any potential infectious complication, we were unable to prevent occurrence of DNM in one of our patients.

Most common signs and symptoms of subcutaneous emphysema are swelling, dysphagia, chest pain, dyspnea and crepitus. Fever and redness are additional symptoms of a potential infection. These symptoms may occur immediately, within few hours or days following the procedure [6,7]. Two patients typically described swelling within few hours after dental procedures.

Imaging plays a crucial role in diagnosis of mediastinal complications caused by dental procedures. Chest x-rays demonstrate widened mediastinum with or without evidence of a pleural effusion in the setting of DNM. CT scan of the neck and thorax usually provide correct diagnosis and reveal mediastinal complications. Cervicothoracic CT can reveal gas and pus collections extending along the cervicothoracic fascia with accompanying abscesses. In all our patients definitive diagnosis was achieved by CT imaging. The differential diagnosis includes cellulitis, hematoma, angioedema, and allergic reaction [16].

Treatment strategy depends on the severity of the condition. Mostly, pneumomediastinum resolve after 3 to 5

days of supportive treatment without any consequences. Antibiotic prophylaxis is indicated, particularly in the presence of underlying respiratory diseases or dental infections. Surgical decompression could only be necessary in the presence of complications such as compression of the thoracic outlet, airflow obstruction, and respiratory failure. However, treatment of DNM and mediastinal abscess cannot be achieved with solely antibiotic administration. Interventional drainage of the mediastinal abscess is necessary in most of the cases for recovery [6,16]. In our 3rd case, interventional drainage of the mediastinum was not considered and surgery remained the optimal option.

In conclusion, dental procedures can cause mediastinal complications. Although pneumomediastinum manifests as a self-limiting condition descending of the oral flora into the mediastinum across the cervical fascial planes and spaces may cause life-threatening complications including deep neck infection, neck abscesses, DNM, mediastinal abscess and empyema. Thus, the use of compressed air could be avoided in dental practice and emergency department physicians should consider these complications when a patient experience with dyspnea, subcutaneous emphysema, fever, neck swelling and/or redness, and chest pain after a dental procedure.

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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Case Report

A rare case of primary synovial sarcoma localized in the thoracic inlet

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ABSTRACT

A 33-year-old male patient was complaining about shoulder pain and swelling in his neck. The computed tomography of the patient revealed a mass lesion extending from the supraclavicular region to the upper level of the aortic arch. The patient was operated with the Grunenwald incision approaching from the anterior. The mass was separated from the tissues and totally excised. The histopathological examination reported a biphasic synovial sarcoma. Here we evaluated a very rare case of primary synovial sarcoma in the context of the literature, localized at the thoracic inlet and excised by the Grunenwald incision.

Key Words: Grunenwald insicion, biphasic synovial sarcoma, thoracic inlet, sarcoma, spindle cell tumors

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Introduction

Soft tissue sarcomas are rarely seen connective tissue tumors. Synovial sarcomas (SS) constitute 5-10% of the soft tissue sarcomas. They are mostly localized at the lower extremities at a rate of 65%, but they can also localized in thorax in rare cases [1]. Since they are aggressive tumors, surgery becomes the major approach in their treatment.

Here, we presented a very rare case of primary synovial sarcoma localized at the thoracic inlet, which was excised by way of the Grunenwald incision.

Case Report

A 33-year-old male patient presented to our clinic complaining about shoulder pain and swelling in his neck. The computed tomography (CT) of the thorax revealed a mass lesion of 82x68 mm extending from the supraclavicular region to the upper level of the aortic arch invading left subclavian artery and scalene muscles (Figure 1). Positron emission tomography revealed a SUVmax value as 5.8. As the pathologic examination of the transthoracic tru-cut biopsy demonstrated Ewing sarcoma, he received six cycles of cisplatin and etoposide chemotherapy. Seeing that there was no regression in the mass and the patient's shoulder pain increased after chemotherapy. Since the patient did not accept the additional treatment after the chemotherapy, the decision for surgical treatment was taken by the oncology council.

Figure 1. Thorax CT showing a mass lesion of 82x68 mm extending from the supraclavicular region to the upper level of the aortic arch.

The patient was scheduled for surgery. The Grunenwald incision was performed with an anterior approach (Figure 2).

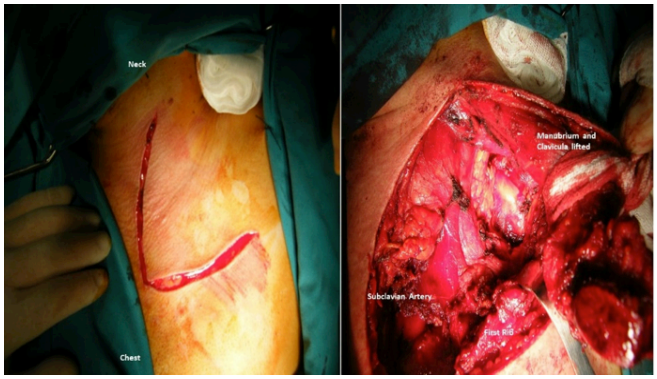

Figure 2. Grunenwald incision and the intraoperative appearance of the mass lesion.

In the exploration, a cystic mass was found tightly adhered the vascular-nerve bundle at the medial, left subclavian artery at the inferior, and brachial plexus, phrenic nerve and scalene muscle at the base. The mass was separated from the surrounding tissues. Wedge resection was performed to the area subject to the invasion in the apicoposterior segment of the upper lobe of the lung ensuring for R0 resection. The postoperative pathology of the patient was reported as biphasic synovial sarcoma (Figure 3). The patient is still being followed up by oncology in his postoperative 2nd year. There were no metastases detected.

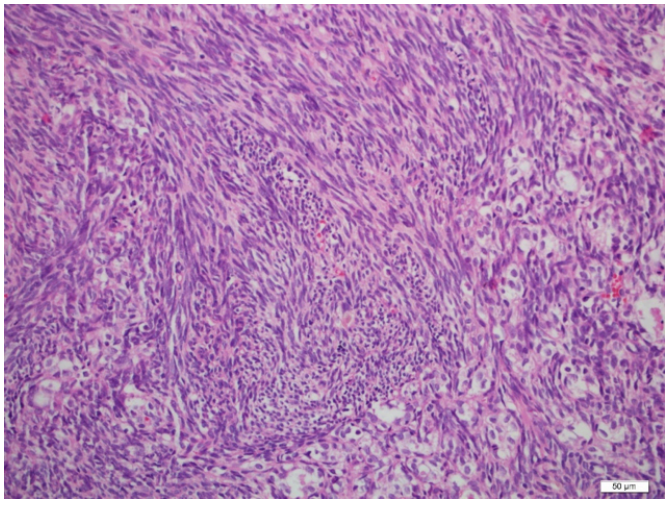

Figure 3. Biphasic synovial sarcomas consist of two components histopathologically composed of spindle cells like epithelioid and fibrosarcoma (Hematoxylin and eosin x20).

Discussion

Synovial sarcomas (SS) are soft tissue tumors typically occurring in adolescents and young adults (between 15 and 40 years of age) and showing mesenchymal and

connective tissue differentiation [1]. They usually involve the larger joints of the extremities. They are rarely localized in the neck, tongue, larynx, heart, esophagus, lungs and mediastinum. 74-81% of them may cause lung metastasis [2]. An SS primarily originated from the lungs was first published by Zeren et al [3]. In our case, it was originated from the thoracic inlet. This localization has been described in the literature very rarely [4,5]. A case where surgical resection could be carried out in this region was not encountered in the English literature.

Patients mostly complain about chest pain. There may also be other complaints including a cough, shortness of breath and hemoptysis [2]. In our case, the patient had severe shoulder pain and swelling in the neck because the tumor was close to the brachial plexus. Lung cancer (superior sulcus tumors), neurogenic and malignant triton tumors should be kept in mind in the differential diagnosis of the thoracic inlet masses.

SS are less chemoradiosensitive tumors compared to Ewing sarcomas. The rate at which they respond to chemotherapy ranges between 28-47% in the publications [6,7]. Fluorescence in situ hybridization analysis identification of the diagnostic chromosomal translocation (t[X;18][p11.2;q11.2]), a marker for this tumor, resulting from fusion of the SYT gene on chromosome 18 to either the SSX1 or SSX2 gene on chromosome X was the most reliable diagnostic method [4,8].

Thoracic inlet tumors are challenging operations for thoracic surgeons due to major vascular and nerve structures. Dartavelle uses an L-shaped incision extended from the anterior of the sternocleidomastoid muscle to the intercostal area, and clavicle and manubrium resection are required [5] In literature, this incision is often preferred for anterior Pancoast tumors [6]. Rarely this technique has been described for subclavian artery aneurysms and sarcomas. The conventional thoracotomy incisions are not sufficient for resection in thoracic inlet tumors. In such cases, the Grunenwald incision enables easy access to thoracic inlet tumors. Unlike the Dartevelle technique, the clavicle is protected in this technique [7]. Both techniques were better defined in terms of patient comfort compared to thoracotomy. Since the patient did not accept the additional treatment after the chemotherapy, the decision was taken by the oncology council for surgery. We also preferred an anterior approach in our patient both to detach the tumor from around the brachial plexus and to reach the apical area of the lung. Furthermore, adverse effects on chest wall mechanics well established after thoracotomy have not been observed with the Grunenwald approach.

In conclusion, primary synovial sarcoma has a poorer prognosis compared to other types of sarcomas. Excision should first be considered as the main treatment in these patients. In particular, the Grunenwald incision is an appropriate approach to better control the thoracic inlet anatomy.

Declaration of conflicting interests

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Case Report

Giant lipoma of the chest wall

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ABSTRACT

Chest wall tumors may originate from the skin, muscles, adipose tissue, nerves and blood vessels, bone and cartilage tissue. Primary malignant tumors of the chest wall are rare. When contextualized, soft tissue stands out as the major origin of primary chest wall tumors. Lipomas, one of the most common benign soft tissue lesions, may mimic malignant masses with their clinical and radiological manifestations. We aimed to present a case of giant lipoma with the complaint of severe pain with the review of the literature.

Key Words: chest wall tumors, giant lipoma, malignancy

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Introduction

Chest wall tumors encompass various tumors of the musculoskeletal system forming the chest wall. Metastatic tumors account for more than half of chest wall tumors. Primary malignant chest wall tumors originate from soft tissue, cartilage and bone tissue [1]. Primary chest wall tumors represent less than 1-2% of all malignancies [2]. Among the primary malignant chest wall tumors, about 55% originate from cartilage and bone tissue, while 45% originate from soft tissue [3]. The most common malignant chest wall tumors are malignant fibrous histiocytoma, chondrosarcoma and fibrosarcoma, while the most common benign chest wall tumors are chondroma, lipoma and fibroma [4].

Lipomas, one of the most common benign soft tissue lesions, may mimic malignant masses with their clinical and radiological manifestations. They rarely exhibit excessive growth and can be termed as giant lipoma, if they are greater than 10 cm in diameter. With their slow growth, well-encapsulated and mobile characteristics, lipomas can be differentiated from other tumoral formations based on clinical findings, and they may be present in the breast tissue.

Case Report

A 61-year-old male patient admitted to the hospital with complaint of a lump in his chest wall. He recognized it 3 years previously and chest pain increased parallel to the progressive enlargement. The physical examination revealed an oval, mobile soft mass lesion in the right hemithorax. The magnetic resonance (MR) of thorax showed a well-demarcated soft tissue lesion with multiple septations extending into the right paracostal muscle structures. The mass was predominantly located under the latissimus dorsi muscle on the right chest wall. The lesion did not cause destruction in the costa and had no relationship with the right hemothorax (Figure 1).

Figure 1. The MR showing the giant mass at the axillary region.

Since the possibility of malignancy could not be eliminated on the examinations carried out, surgical intervention was planned for diagnosis and treatment. The patient was placed in the right posterolateral position and via a 10 cm incision across the right anterior axillary and nipple line, which was above the fifth costa, the mass was observed under latissimus dorsi muscle, and excised totally. No costal invasion was present (Figure 2). Histolopathologic examination confirmed lipoma.

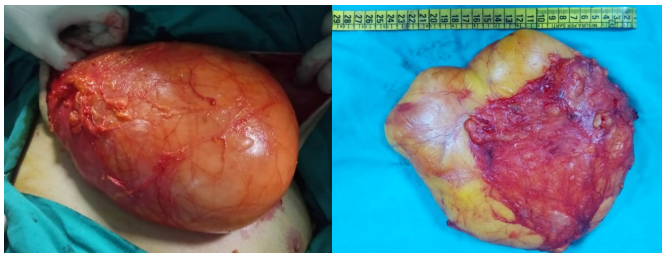

Figure 2. Intraoperative appearence of the giant lipoma **(a)**, the lesion was 22 cm in diameter **(b)**.

The patient was discharged on the third postoperative day uneventfully.

Discussion

Chest wall tumors grow slowly and do not show symptoms in the first stage. However, as the tumor grows, they begin to manifest symptoms. Especially malignant chest wall tumors are more symptomatic. Pain and swelling are the most common symptoms. Lipoma is a slow-growing, benign, painless, mobile, oval and round soft tissue tumor. Although lipoma arises in all age groups, it typically occur in adults aged from 40 to 60 years. In general, it is identified in the subcutaneous tissue of the back, shoulder, head and neck. The skin overlying the lesion appears normal. It is easily detected on physical examination, usually does not require treatment. This tumor may also be found in deep tissues such as the thorax, intra-abdominal organs and intermuscular septae [5,6]. They rarely exhibit excessive growth and can be called giant lipoma, if they grow greater than 10 cm in diameter. With their slow growth, well-encapsulated and mobile characteristics, lipomas can be differentiated from other tumoral formations based on clinical findings, and they may also be present in the breast tissue [7]. Besides conventional radiology, CT is also important for the diagnosis of chest wall tumors. Especially in the diagnosis of neural tumors, magnetic resonance imaging is very important in determining the relationship of the tumor with vascular

structures and mediastinum. In addition to chest x-ray, CT was performed on our patient. On CT, lipoma is usually visualized as a well-demarcated mass consisting of almost completely mature adipose tissue. This imaging technique also shows the lesion related invasion in adjacent tissues. In chest wall tumors, it may be clinically and radiologically challenging to differentiate whether the lesion is benign or malignant. Needle aspiration, incisional biopsy or excisional biopsy can be used in the diagnosis of these tumors. However, needle aspiration and incisional biopsy may cause the tumor to spread along the biopsy tract. Therefore, as far as possible, complete resection of the tumor and making a definitive diagnosis should be ensured. In cases with suspicious surgical margin, the analysis of frozen sections is absolutely necessary. Considering the advanced growth of the mass and inevitable total excision due to its location in the case, surgical resection was carried out without considering the surgical biopsy methods, and the definitive diagnosis and treatment were provided. The histopathological examination of the mass was reported as giant lipoma.

In conclusion, lipomas, which are most commonly benign soft tissue lesions of the chest wall, can mimic malignant masses with clinical and radiological manifestations. Surgical interventions and pathological examinations performed for definitive diagnosis may bring surprising results. Especially in cases of ignored pain and swelling, necessary diagnostic procedures should be performed promptly, and large resection should not be avoided in operable cases.

Declaration of conflicting interests

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Figures that are charts, diagrams, or drawings must be submitted in a modifiable format, i.e. our graphics personnel should be able to modify them. Therefore, if the program with which the figure is drawn has a "save as" option, it must be saved as *.ai or *.pdf. If the "save as" option does not include these extensions, the figure must be copied and pasted into a blank Microsoft Word document as an editable object. It must not be pasted as an image file (tiff, jpeg, or eps) unless it is a photograph.

Tables and figures, including caption, title, column heads, and footnotes, must not exceed 16×20 cm and should be no smaller than 8 cm in width. For all tables, please use Word's "Create Table" feature, with no tabbed text or tables created with spaces and drawn lines. Please do not duplicate information that is already presented in the figures.

Tables must be clearly typed, each on a separate sheet, and double-spaced. Tables may be continued on another sheet if necessary, but the dimensions stated above still apply.

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