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Original Article

Starting experience in robotic thoracic surgery

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ABSTRACT

Background: The robotic assisted thoracoscopic surgery (RATS) spreads rapidly across the whole world. In this paper, the objective was to present the training experience on RATS in our clinic along with the literature.

Materials and Methods: Sixty-three consecutive patients, who had undergone RATS between February 2014 and December 2018, were included in this retrospective non-randomized study. The training period was designed as three phases. Twelve patients with solid and cystic mass lesions in the mediastinum and chest wall were included in group Phase 1. The group Phase 2 consisted of 16 patients who had thymoma and benign pulmonary mass lesions, and 35 consecutive patients were enrolled into group Phase 3 group who had undergone lobectomy.

Results: The patients in all groups were compared in respect of the preoperative, perioperative and postoperative results. The docking time was significantly shorter in Phase 3 patients compared to the groups Phase 1 and 2 ($p < 0.05$). In the lobectomy group (Phase 3), as the console time and operation time was significantly shorter after the 20th patient than the prior patients, first 20 patients were accepted as the learning curve ($p < 0.05$). In the lobectomy group, in three patients the operation was converted to open surgery during the perioperative period (4.7%). No mortality was observed during the 30-day follow-up. One patient died in the 6th month of the long-term follow-up. The mean follow-up duration was 28.4 months.

Conclusions: RATS is a safe, feasible, and minimally invasive method, which has low complication rates with a satisfying and short learning curve.

Key Words: robot-assisted thoracoscopic surgery, robotic lobectomy, minimally invasive thoracic surgery, robotic surgery

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Introduction

The robotic surgery spread rapidly across the world following its introduction in the early 2000s. The implementation of the minimally invasive surgery with high technology got an edge over the open surgery depending on the surgical tools with the maneuver capacity of a human wrist, filtration of the physiological tremor (6-Hz motion filter), good dissection capacity in hard-to-access fields, 3D imaging possibility, and 10x magnification capacity [1]. However, the control of the surgical tools with the joystick on the console (instead of directly next to the patient), the absence of tactual sense and position impingement of the robotic arms are its disadvantages. These advantages can only be eliminated with a well-thought-out training. It was reported that the complications, which might be related to surgeons, who used to perform open surgery or video-assisted thoracoscopic surgery (VATS), might have high mortality rates [2]. Therefore, the robotic surgery training is essential. The developments in robotic technology enabled the introduction of different robotic arms for different specialties, which made robotic surgery easier. Thus, different robotic trainings are necessary for each surgical specialty.

As there was no training clinic in the clinic of thoracic surgery, the objective was to evaluate the RATS training process extending from simple interventions to lobectomies in the light of the relevant literature.

Materials and Methods

Sixty-three patients, who had undergone RATS between November 2014 and December 2018, were selected from a total of 605 patients who had undergone a surgical intervention, and included in this retrospective study. Twelve patients, who did not need vascular and/or bronchial resection and ligation before robotic surgery and their operation fields were close to these structures were included in group Phase 1. 16 patients, who had benign and malign lesions in the close neighborhood to the vascular, bronchial structures needing ligation/closure of the vascular and minor bronchial structures, were gathered in group Phase 2. After the completion of this phase, 35 patients, who had undergone lobectomy, were included in group Phase 3.

All patients had undergone preoperative chest computed tomography examination. Patients, who were diagnosed with malignancy or were considered to have a malignancy, were examined with PET/CT and cranial MRI. Standard blood count, biochemical analysis, and pulmonary function testing were also performed. Patients, who were scheduled for RATS but had FEV1 < 1.5 L and had central lesions or lesions larger than 5.1 cm, were not included in the RATS lobectomy program.

All interventions were done by a single surgeon and in same operating room with the da Vinci Robotic System SI (Intuitive Surgical Inc., Mountain View, California, USA).

The operation time for each patient was recorded as the sum of docking time, console time and closure duration. The docking time was defined as the time between the first incision and the sitting of the surgeon at the console. The console time was defined as the time starting from the sitting of the surgeon at the console and ending with the removal of the resected material and undocking of the robotic arms from the patient following the bleeding and air leak control. The closure time started from the undocking of the robot and ended with the closure of the last incision.

Only one thoracic drain was inserted in all resections (28F thoracic tube, thorax drainage system, Bıcakcılar, Istanbul, Turkey). The drains were removed after the daily drained volume declined below 200 mL and no air leak was determined.

Surgical Technique

Following the double-lumen intubation, the patient was positioned in the semi-lateral position in thymoma cases and in the lateral decubitus position in other cases. The ports were so positioned that they were as far as possible to the lesion in order to enable the robotic arms to function smoothly. The distance between the ports was approximately 8-10 cm. The robot was directly positioned at the front of the lesion. Docking was adjusted so that the arm might move towards the lesion and the robot and the transverse axis of cart angle to the vertebral column was 30-45°. The surgeon next the operation table stood on the side of the access port and the vision cart was adjusted so that the surgeon next to the operation table, anesthesiologist and the nurse could see the monitor.

Three ports were used in Phase-1 patients and 3 ports and 1 access port in Phase 2 patients. The camera was inserted through the middle port. The interventions were performed with 3 ports and 1 access port in the first 20 cases in group Phase 3 and with 4 ports and 1 access port in the remaining patients (the latter group). In all interventions, a 30° camera was used in the up position during the access and in the down position during the resections. Regarding the locations of the ports in Phase 3 patients, the first port (camera, 12 mm) was inserted at the 7th intercostal space (ICS) on the posterior axillary line, the second port (12 mm) at the 6th ICS on the subscapular line (also used for the stapler), the third port (8 mm) at the 5th ICS on the anterior axillary line, and the fourth port at the 6th ICS with a distance of 3 cm to the paravertebral transverse process and the access port was inserted between the camera and anterior axillary line, third port at the 6th ICS with a 3 cm distance to the costodiaphragmatic symphysis. The access port was also used for the suction, retracting and removal of the materials [3].

During lobectomy, Maryland bipolar curved forceps (first arm) was inserted through the 2nd port, which was on the right side of the camera. Prograsper (second arm) was inserted through the 3rd port, which was on the left side of the camera and the second prograsper (third arm) was inserted through the 4th port, which was on the right or left side of the camera depending on the lateral positioning of the patient. In patients, who had an undiagnosed peripheral mass lesion, first 3 ports were opened at corresponding places. Lesions were resected and referred to frozen section for histopathologic analysis. In patients, in whom frozen section examination showed malignancy, the 4th and access ports were opened and robotic surgery was implemented.

The operative mortality was defined as the mortality due to any cause before the discharge within the first 30 days. In patients, who were converted to open surgery during the perioperative period, the results were evaluated according to the cause, postoperative morbidity/mortality, pathological analysis, and hospitalization duration.

The study protocol was approved by the local Institutional Review Board (Approval no: 2018/57), informed consent was obtained from each patient before the inclusion in the study.

Statistical Analysis

The data were collected and recorded on an Excel sheet (Microsoft Corporation, Seattle, WA). The mean, standard deviation, median, minimum, maximum values, frequency, and percentage were used for the descriptive statistics. The distribution of variables was checked with the Kolmogorov-Smirnov test. Mann-Whitney U test was used for the comparison of quantitative data. Chi-Square test was used for the comparison of qualitative data. SPSS 22.0 software package was used for statistical analyses. The statistical significance level was considered as $p < 0.05$.

Results

63 patients (26 males (41.3%) and 37 females (58.7%)) with a mean age of 55.4 ± 16.6 years had undergone RATS. The mean lesion size was 3.8 ± 1.2. Regarding all patients, the docking time, console time, operation time and length of hospitalization were 19.8 ± 6.5, 105.0 ± 64.4, 137.5 ± 73.4, and 6.2 ± 3.3 respectively. The robotic surgery-training program was designed in three phases. The age, sex, lesion side, lesion dimension, docking time, console time, and operation time, number of switches to the open surgery, complications, length of hospitalization and mortality rates of patients in all three groups were listed in table 1.

Table 1. Demographic data, perioperative and postoperative results.

	Phase 1	Phase 2	Phase 3	p
Age	48.3±17,2	48.1±19,8	61.1±12.5	0.017^{K}
Gender (M/F) n, (%)	3 (25)/9 (75)	8 (50)/8 (50)	9 (25)/26 (74)	0.008^{X2}
Lesion side (R/L) n, (%)	10 (83)/2 (16)	7 (43)/9 (56)	21 (60)/14 (40)	0.106^{X2}
Lesion size (cm)	4.6±1.1	4.5±2.2	3.1±1.1	0.004^{K}
Docking time (min)	29.08±7.7	19.3±2.9	16.9±3.8	0.000^{K}
Consol time (min)	28.16 ±10.1	62.1±33.5	151.1±43.7	0.000^{K}
Operation time (min)	63.9±15.7	87.2±35.5	185.7±60.7	0.000^{K}
Conversion n, (%)	0	0	3 (8.5)	p>0.05
Complication n, (%)	0	3 (18.7)	11 (31.4)	p>0.05
Lenght of stay	2.8±1.2	5.0±1.5	6.9±3.2	p<0.05
Long-term mortality (%)	0	0	1 (2.8)	p>0.05

^{K} *Kruskal-Wallis (Mann-Whitney u test)* ^{X2} *Chi-square test (Fischer exact)*

Regarding the 12 cases in group Phase 1, 5 patients underwent pericardial cyst excision, 2 patients pericardial window surgery, 2 patients sympathetic chain removal, 2 patients Schwannoma resection, and 1 patient underwent excision of the esophageal duplication cyst. The cystic lesions were excised totally after the aspiration of the cyst content. There was no need for VATS or thoracotomy in patients in group Phase 1. No mortality was encountered in the first 30 days after the surgery and no recurrence emerged during the long-term follow-up.

The 16 cases, who were included in group Phase 2, did not show a significant difference regarding the age, sex, and lesion size compared to group Phase 1 ($p < 0.05$). Three patients underwent thymothymectomy due to the thymoma, 3 patients bullectomy and parietal pleurectomy due to the bullous emphysema, 3 patients enucleation due to the hamartoma, 3 patients cystotomy and capitonnage due to the pulmonary cyst hydatid and 4 patients wedge resection due to the solitary pulmonary nodule. In cyst hydatid cases, we aspirated first the cyst content and then the germinative membrane was removed with endobag (Endobag, Covidien, Mansfield, MA, USA). The docking time was significantly shorter in this group compared to group Phase 1. However, the console time and operation time were significantly longer compared to group Phase 1 ($p < 0.05$). Three patients (18.75%) had a prolonged air leak, which was controlled with conservative treatment in two cases. One of the cyst hydatid cases applied with air leak (pneumothorax) after the discharge and underwent minithoracotomy. The bronchial leak was closed and the patient was discharged without any complication. No mortality or recurrence were observed in this group during the 30-day and long-term follow-up (Table 1).

In the group Phase 3 (n = 35); 29 patients (82.8%) had primary pulmonary malignancy, 3 patients (8.5%) metastatic lung carcinoma and 3 patients (8.5%) benign lesions. All patients underwent lobectomy. In patients with primary lung carcinoma, mediastinal lymph node dissection was added to the intervention. R0 resection was achieved in all cases with a primary lung tumor and all visible N2 lymph nodes were completely removed. Although the docking time was significantly shorter in Phase 3 compared to Phase 1 and Phase 2 cases, the console time and operation time was significantly longer than both of groups ($p < 0.05$) (Table 1).

The lobectomy cases, who targeted group Phase 3, were scheduled for RATS and underwent a much more detailed examination compared to the other two groups. The mean docking time, console time and operation time after the first 20 Phase 3 patients were significantly shorter than the first 20 patients ($p < 0.05$) (Figure 1).

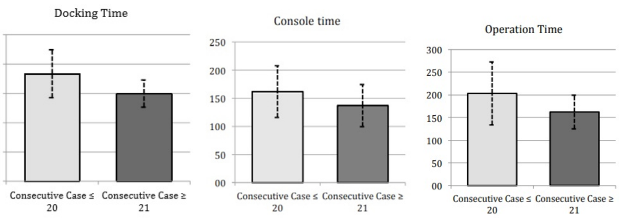

Figure 1. Docking time of first 20 and latter cases **(a)**, console time of first 20 and latter cases **(b)**, operation time of first 20 and latter cases **(c)**.

Therefore, the first 20 cases were accepted as the learning curve (Table 2). There was no significant difference between the patients in the learning curve group and the remaining patients in the latter group regarding the demographic characteristics ($p > 0.05$). The lobectomy distribution of both groups is summarized in Table 3. In the lobectomy group, in 3 patients, the intervention was converted to open surgery during the perioperative period. The reason of the conversion was pulmonary artery bleeding (right upper lobe anterior segment artery and left lower lobe common basal segment pulmonary artery) in two cases and device dysfunction (stapler locked during the bronchial division in the right upper lobe). Hemorrhage was observed in one patient in each group. The mean hospitalization time in the ICU was 1 day (0-2 days). There was no significant difference between the learning curve group and the latter group regarding the conversion to thoracotomy ($p > 0.05$).

Considering the whole Phase 3 lobectomy group, 11 patients (31.42%) had co-morbidities; 5 patients (14.28%) had prolonged air leak, 4 patients (11.42%) atrial fibrillation, and 2 patients (5.71%) pneumonia. The air leak was treated with conservative methods; in one case, it was brought under control with minithoracotomy on the 14th postoperative day. Three of 4 patients, who developed atrial fibrillation, was converted to the sinusoidal rhythm with amiodarone infusion and one patient with cardioversion. Patients with pneumonia were treated with antibiotics.

Table 2. Preoperative and postoperative data of learning curve and latter patients.						
		Consecutive Case≤20 Mean±sd/n-%	Median	Consecutive Case≥21 Mean±sd/n-%	Median	P
Age		58.2±13.8	62	65.0±9.6	66	0.171^{m}
Gender	M F	5 (25.0%) 15 (75.0%)		4 (26.7%) 11 (73.3%)		0.911^{X2}
Lesion side	R L	13 (65.0%) 7 (35.0%)		8 (53.3%) 7 (46.7%)		0.486^{X2}
Lesion size		3.4±1.2	3.5	2.8±0.8	2.8	0.486^{X2}
Docking time		18.4±4.1	17.5	14.9±2.3	15.0	0.008^{m}
Console time		161.7±45.9	160.0	136.9±37.5	132.0	0.032^{m}
Operation time		203.3±69.5	192.0	162.3±37.1	155.0	0.009^{m}
Conversion (Thoracotomy)	(-) (+)	19 (95%) 1 (5.0%)		13 (86%) 2 (13.3%)		0.565^{X2}
Hospitalization time		6.4±3.6	6.0	7.5±2.7	7.0	0.117^{m}

Abbrev.; M: male, F: female, R: right, L: left,
^{m} Mann-Whitney u test, ^{X2} Chi-square test (Fischer exact)

Table 3. The distribution of lobectomies and pathological classification.

Operations performed	Learning curve	Latter patients	Total, n (%)
Right upper lobectomy	7	4	11 (31.4)
Middle lobectomy	2	-	2 (5.7)
Right lower lobectomy	3	4	7 (20)
Left upper lobectomy	3	4	7 (20)
Left lower lobectomy	5	3	8 (22.8)
Pathological diagnosis			
Adenocarcinoma	9	8	17 (48.6)
Squamous cell carcinoma	4	4	8 (22.9)
Small cell carcinoma	2	-	2 (5.7)
Metastatic lung cancer	2	1	3 (8.5)
Carcinoid	1	1	2 (5.7)
Bronchiectasis	2	-	2 (5.7)
Sequestration	-	1	1 (2.8)
Total	20	15	35 (100)

The pulmonary malignancy was the most common result in the pathological examination in lobectomy group (n = 32; 91.4%). Considering 29 patients with primary lung carcinoma, 17 of them had adenocarcinoma (58.62%), 8 squamous cell carcinoma (27.58%), 2 patients small cell carcinoma (6.89%) and 2 patients carcinoid tumor (6.89%) (Table 3). The pathological staging was as follows: 12 cases Stage I (IA n = 6, IB n = 6), 14 cases Stage II (IIA n = 8, IIB n = 6) and 3 cases Stage IIIA (n = 3).

All patients were examined with complete blood count, biochemical analysis, ECG, and posteroanterior chest x-ray examination on postoperative days 10, 30 and 90, and then at 3-month intervals. The mean follow-up duration was 28.4 months (2-56 months). No mortality was observed during the short-term follow up (30-90 days). One patient (2.85%) with metastatic lung carcinoma (colon adenocarcinoma) died in the 6th month after surgery in the Phase 3. The remaining cases are under follow-up and are disease-free.

Discussion

The robotic surgery becomes more popular from day to day and its spectrum becomes wider. Depending on the shorter hospitalization and lower complication rates and technological development in the robotic arms, robotic surgery became preferable against VATS and thoracotomy [4]. Therefore, efforts to develop RATS training programs are steadily increasing.

There are articles in the literature, which indicate that robotic surgery training should have 3 phases. Ricciardi et al. [1] recommended that a simulator should be used in the first phase. The observation of the interventions implemented by an experienced surgeon, training on animals and cadavers should be considered in the second phase and in the third phase, the candidate should perform robotic surgery starting from simple cases with a dual console if available, if not under the supervision of a proctor. Some studies had divided three phases as 1st, 2nd and 3rd phase operations [5-7]. Like the recommendations in the literature, we planned our training in three phases after a lobectomy practice period on pigs [6-8].

In group Phase 1, the absence of complication and mortality and short hospitalization time was consistent with the literature [9]. In group Phase 2, we selected 2nd level pathological conditions similar to the literature [6-8]. In the Phase 2 patients, the rate of air leak (n = 3) was also similar to the results in the literature [10]. In the third and targeted last phase, who were planned for lobectomy operation, were included [7,10-12]. The mean docking time in all groups was consistent with the literature [11]. In the Phase 3 group, it is observed that docking time became significantly shorter along with the increase in experience. The significantly longer operation time in Phase 3 patients compared to Phase 1 and 2 patients was related to the complicated cases. Nevertheless, the results were consistent with the results in the literature (Table 4).

In group Phase 3, the first 20 cases were accepted as the lobectomy learning curve, as the docking time, console time and operation time were shortened after these cases. In various studies, the investigators reported that the operation time for lobectomy was between 104 and 226 minutes after the learning curve. The same time was 136.9 minutes in our study, which was consistent with the results of the published studies [13-14]. The curve representing the operation time of the first 20 patients showed a statistically significant decline (Figure 2).

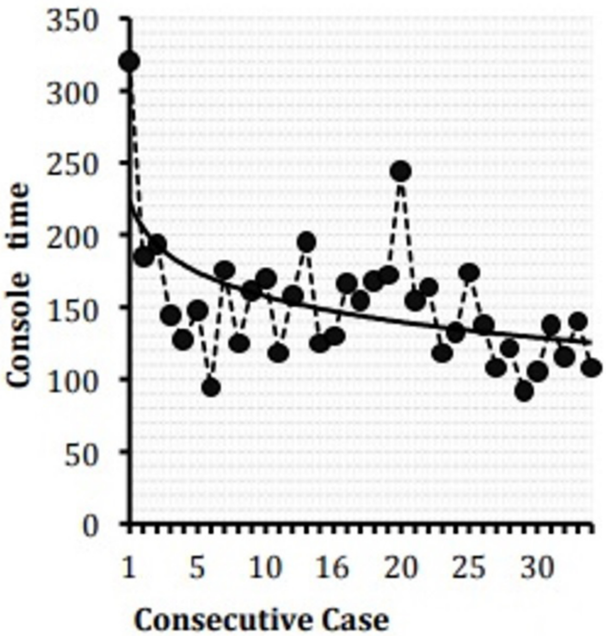

Figure 2. Learning curve.

The learning curve case number was 18 in the study, which was conducted by Veronesi et al. [15] (n=91), depending on operation time and hospitalization time and 14 in the study of Toker et al. [11] (n=102) depending on the docking time, console time and operation time. Huang et al. [16] conducted a study with 389 cases and reported the first 20 cases as the learning curve depending on the decrease in the complication and mortality rates. Melfi et al. [12] suggested that at least 20 cases were needed. It was reported that the general assumption was between 14-21 cases [17-19].

In some studies, the interventions were performed with 3 arms [14]. Although most of the RATS surgeons reported that they were using 3 arms and 1 access arm, Cerfolio et al. [20] recommended using of 4 arms. We used 3 arms and 1 access arm in our first 20 learning curve cases but then we switched to 4 arms and 1 access arm technique. We might suggest that the Complete Portal Robotic Lobectomy-4 (CPRL-4) 4-arm method enabled a better exposure with the CO2 insufflation, less microhemorrhage and consequently a shorter operation time. However, there are also studies, which reported that the complication rate was not decreased and it had no superiority over 3-arm technique or VATS [22].

Although we switched to thoracotomy in 3 cases (4.7%), all cases were in the lobectomy group. Regarding the literature, the conversion rates changed between 0% and 17%. There was no statistically significant difference between the learning curve group and the latter group in respect of conversion rates. The published studies showed that conversion rates declined in the learning curve and the latter groups [15,16,23]. Apparently, the relatively small number of the cases in the latter group was not adequate for an evaluation of the conversion rate.

In this study, we encountered complications in 14 patients (22.2%). 11 of these cases were in the lobectomy group. The reported complication rates in the literature were between 9% and 43%. The most common complications were prolonged air leak and arrhythmia. In some studies demonstrated that the most common complications were prolonged air leak and arrhythmia [8,16,25]. There was no statistically significant difference between the lobectomy learning curve group and the latter group regarding the complications. There are also other studies reporting that the console time and operation time were longer in the learning curve cases but the complication rates did not significantly differ [26].

None of the patients died during the 30-day and 90-day follow-up. One patient (1.5%) died during the long-term follow-up in all groups (mean duration 28.4 months). The 30-day and 90-day follow-up mortality rates in the literature (0%-3%) are comparable to our mortality rate. The mortality rate was 3% in the study of Toker et al. [11] during the 13-month follow-up. In the study of Veronesi et al. [22], none of the patients died at the early stage but the mortality rate became 3.29% (n = 3) during the 24-month (mean) follow-up. There are limited number of studies that reported 5-year follow-up periods [14]. Park et al. [21] conducted a multicenter study with 325 subjects and the disease-free survival rate was 80% (91% for Stage IA; 88% for Stage IB and 49% for Stage II). In a study of Yang et al. [27] (n = 175), the 5-year survival rate and the disease-free rates were 77% and 72% respectively. Our long-term follow-up results were consistent with the literature. Our 5-year follow-up results are not available yet.

The reported hospitalization duration was between 2 and 10 days in the literature. In our study, the hospitalization duration was 6.2 days. Although these results were within the limits of the interval in the literature, it is higher than the mean value. This result might depend on the absence of the outpatient drain follow-up [5,11].

VATS and robotic surgery were compared in several studies. Both of these techniques provide satisfying results in cancer surgery comparable to open surgery. VATS is usually performed with 2 incisions, while 4-5 incisions are used in RATS [24]. Although a larger number of incisions did not increase morbidity, it may aggravate postoperative pain. The operation time is generally longer in RATS, although recent studies showed that the operation time further shortened and became comparable to VATS [16]. In the same article, it was reported that the perioperative bleeding rate was lower in RATS. The intrathoracic maneuverability of the robotic surgery tools, a fixed camera with a 10x magnification capacity, 3D visualization, less pain, more comfortable esophagus surgery, and lymph node dissection are the advantages of RATS over VATS [19,25]. It was reported that the number of cases for the learning curve is smaller in RATS compared to VATS [28].

Veronesi et al. stated that 20 cases were enough for the learning curve in RATS but insufficient for VATS [15]. However, the high cost of RATS limits its advantages.

Besides on rapid training, RATS could be further supported with a 3-day surgery practice under the supervision of a mentor, promotion of the robotic system basics and tools within a program and multiple “tricks of trade” publishing. In addition, software packages such as “MIST-VR” and SI double-console can accelerate the training. Furthermore, consensus studies on robotic surgery training are ongoing.

Limitations of the Study

Our study on robotic training had a retrospective design. Randomized and controlled studies with prospective design are needed. The limited number of cases in the latter lobectomy group (cases after the learning curve), the absence of 5-year long-term follow-up results, quality of life, and cost analysis are the limitations of our study.

As a conclusion, regarding lobectomy, 20 cases might be considered as sufficient for robotic surgery training. Depending on the steep learning curve, robotic surgery is a safe, feasible, and minimally invasive surgical method with low complication and high success rates.

Declaration of conflicting interests

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Table 4. Data regarding robotic resections.

Authors	Year	n	Age (year)	Op. time (min)	C (%)	Mrt (%)	Mrb (%)	Hospital stay (day)
Toker et al. [11]	2015	102	60±13	104 (50-230)	4	2	24	5 (2-42)
Anderson et al. [14]	2007	21	67 (36-86)	216 (60-384)	0	0	27	4 (2-10)
Veronesi et al. [15]	2011	91	NP	226 (146-513)	11	0	27	5 (3-38)
Huang et al. [16]	2018	389	55 (20-76)	91±30	4	0	9	4 (2-12)
Gharagozloo et al. [17]	2009	100	65±8	216±27	1	3	31	4 (3-42)
Meyer et al. [18]	2012	185	65±9	211±60	1.6	1.6	16.8	4 (2-21)
Lee et al. [19]	2014	35	71 (52-84)	161 (104-272)	2.9	0	11	3 (2-6)
Cerfolio et al. [20]	2011	106	66 (31-85)	132±60	11.9	0	27	2 (1-7)
Park et al. [21]	2012	325	66 (30-87)	206 (110-383)	8.3	0.3	25	5 (2-28)
Louie et al. [24]	2012	46	65	213	5.7	0	43	4 (2-21)
Giulianotti et al. [29]	2010	38	66 (16-78)	209±66	15.7	2.6	10.5	10 (3-24)
Current study	2019	63	55±16.6	137.5±73.4	4	1	22	6 (1-18)

Abbrev.; Op. time: operation time, min: minute, C: conversion, Mrt: mortality, Mrb: morbidity

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Original Article

Evaluation of the effect of video-assisted thoracoscopic surgery on early postoperative pain and quality of life

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ABSTRACT

Background: Video-assisted thoracoscopic surgery (VATS) is more advantageous than open surgery. In particular, VATS is superior in terms of pain, physical functioning, and overall patient satisfaction. The aim of this study was to evaluate factors affecting early postoperative pain and quality of life in patients who underwent VATS for benign or malignant disease.

Materials and Methods: Seventy-seven patients who underwent VATS in our hospital between March 1 and June 30, 2018 were evaluated retrospectively. Postoperative pain was assessed at 2, 6, and 24 hours postoperatively using Visual Analogue Scale (VAS). The short-form 36 (SF-36) quality of life questionnaire was used to assess early quality of life.

Results: Of the 74 patients in the study, 50 were male (67.6%) and 24 were female (32.4%). Mean VAS score was 6.84 ± 1.63 at postoperative hour 2, 4.19 ± 1.36 at postoperative hour 6, and 2.58 ± 1.20 at postoperative day 1. Geriatric patients had significantly higher VAS pain scores at postoperative hour 6 and day 1 ($p = 0.011$, $p = 0.013$). Patients with benign disease had significantly higher quality of life compared to patients with malignancy ($p < 0.001$). The presence of complications and advanced age were associated with lower postoperative quality of life.

Conclusions: Although VATS patients have less severe pain and better quality of life in the early postoperative period, patients with malignancy had worse physical, psychological, and emotional state. In addition, geriatric patients and patients with early postoperative complications showed larger decreases in early postoperative quality of life.

Key Words: quality of life, video-assisted thoracoscopic surgery, tumor, lung cancer, treatment

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Introduction

Video-assisted thoracoscopic surgery (VATS) is a minimally invasive approach commonly used in thoracic surgeries for both diagnostic and treatment purposes. VATS is particularly advantageous compared to open methods in terms of pain, complications, and length of hospital stay [1]. This is primarily due to better pulmonary function, activity level, muscle power, and walking capacity.

Postoperatively, the patient's quality of life is as important as treating the disease. There are publications suggesting that quality of life must be improved to increase treatment adherence, especially for patients who require long-term treatment. However, it is still uncertain whether thoracoscopic surgery is superior in terms of quality of life. The main reasons for this are that previous studies applied different scales, had patient selection bias, and were conducted in selected populations [2-6].

The aim of this study was to evaluate factors affecting early postoperative pain and quality of life in patients who underwent VATS for benign or malignant disease.

Materials and Methods

Seventy-seven patients who underwent VATS in our hospital between March 1, 2018 and June 30, 2018 were evaluated for the study. Three patients did not provide consent and were excluded from the study. Thus, the records of 74 patients were analyzed retrospectively from a database created with standardized data collection.

The patients in the study were divided into those with malignant disease and those with benign disease. Postoperative pain was assessed at 2, 6 and 24 hours postoperatively using the visual analog scale (VAS) (0 = "no pain" to 10 = "worst pain").

The patients were analyzed in terms of demographic data, morbidity, length of hospital stay, and histopathological characteristics. Ethics committee approval for the study was obtained from the Istanbul Training and Research Hospital.

Patient Selection

For patients with malignancy, tumor location and invasion were assessed preoperatively with routine thoracic computed tomography (CT). Positron emission tomography was used to assess distant and mediastinal metastases. Contrast-enhanced cranial magnetic resonance imaging was performed to assess cranial metastases. All patients underwent preoperative bronchoscopy. Mediastinal examinations were performed with endobronchial ultrasound (EBUS) and/or mediastinoscopy. Pulmonary function testing (PFT), arterial blood gas analysis, and electrocardiography (ECG) were requested routinely to evaluate cardiopulmonary capacity. Patients with cardiac comorbidities were assessed with ECG by the cardiology department. Patients with percent predicted forced expiratory volume in 1 second (ppFEV1) of 40% or below in preoperative PFT were subjected to further pulmonary assessment with diffusing capacity of the lung for carbon monoxide (DLCO) testing, pulmonary perfusion scintigraphy, and 6-minute walk test.

For patients with bullous pulmonary disease, preoperative thoracic CT was requested for those with suspected secondary pneumothorax. Patients with benign disease underwent the same preoperative pulmonary and cardiac evaluations as those with malignancies.

Comorbidity score was calculated according to the 19-parameter Charlson Comorbidity Index (CCI), introduced in 1987 [5]. Patients were divided based on CCI values into a 0-1 group and ≥2 group.

Postoperative Pain Management

Intercostal blockage with bupivacaine hydrochloride is performed at intraoperative in all patients. In the postoperative period, pain control of the patients was achieved with paracetamol and diclofenac sodium.

Complications that occurred in hospital or within the first 30 days postoperatively were evaluated as early complications. Quality of life was assessed at postoperative 1 month using the short-form 36 questionnaire (SF-36).

Statistical Analysis

Numerical variables were evaluated using mean and standard deviation or median (minimum-maximum) and categorical variables using number and percentage. Parametric test assumptions (normality and homogeneity of variances) were checked before comparing the groups in terms of numerical variables. Dependent samples t test was to analyze the differences between pre- and postoperative quality of life scores. Kruskal-

Wallis test was used to compare the surgical treatment groups with respect to quality of life. P value <0.05 was considered statistically significant. All analyses were done using SPSS (version 22, SPSS Inc., Chicago, IL, USA) package software.

Results

Of the 74 patients in the study, 50 were male (67.6%) and 24 were female (32.4%). Their mean age was 45.18 ± 17.06 years. Ten (13.5%) of the patients were over 65 years old and 64 patients (86.5%) were less than 65 years old. The mean length of hospital stay was 4.77 ± 2.41 (range, 2-13) days. Twenty-seven (36.5%) of the patients had no comorbidities. The demographic features of the patients are summarized in table 1.

Table 1. Demographic characteristics of the patients.

Variables		n	%
Age (years)		45.18±17.06	
Age	<65 years	64	86.5
	>65 years	10	13.5
Gender	Male	50	67.6
	Female	24	32.4
Comorbidity (CCI)	0	27	36.5
	1	9	12.2
	2	11	14.9
	3	3	4.1
	4	7	9.5
	5	2	2.7
	6	6	8.1
	7	2	2.7
	8	3	4.1
	9	3	4.1
	12	1	1.4
Procedure	Therapeutic	46	62.2
	Diagnostic	28	37.8

Abbrev.: Vats; video Assisted Thoracoscopic Surgery, CCI: Charlson Comorbidity Index

Histopathology results indicated malignancy in 18 (24.3%) of the patients in the study and benign disease in 56 (75.3%). Surgery was performed on the right side in 44 patients (59.5%) and on the left side in 30 patients (40.5%). There were no statistically significant differences between patients with malignant and benign disease in terms of operated side, number of ports, or type of procedure (p > 0.05).The histopathological and surgical data of the patients included in the study are presented in table 2.

Table 2. Histopathological and surgical data of the patients.

Variables			n	%
Operated Side	Right		44	59.5
	Left		30	40.5
Number of ports	1		33	44.6
	2		36	48.6
	3		5	6.8
Procedure	Wedge resection		35	47.3
	Biopsy		31	41.9
	Lobectomy		5	6.8
	Cyst Excision		3	4.1
Histopathology	Malignant		18	24.3
	Benign		56	75.7
Malignant	Pleural Biopsy	Mesothelioma	5	27.8
		Adenocarcinoma metastasis	1	5.6
	Resection	Primary lung carcinoma	4	22.2
	Metastasectomy	Secondary lung carcinoma	5	27.8
Benign	Resection	Bronchiectasis	1	1.8
	Wedge	Hamartoma	3	5.4
		Pneumothorax	12	21.4
		ILD / Organized pneumonia	17	30.4
	Cyst excision	Bronchogenic cyst	1	1.8
		Pericardial cyst	1	1.8
		Thymic cyst	1	1.8
	Pleural biopsy	CNP	21	37.5

Abbrev.: CA: carcinoma, CNP: chronic nonspecific pleuritis, ILD: interstitial lung disease

Eleven patients (14.9%) developed complications. Prolonged air leak occurred in 5 patients (6.8%), postoperative hemorrhage requiring revision in 1 patient (1.4%), chylothorax in 1 patient (1.4%), atelectasis requiring bronchoscopy following secretion retention in 1 patient (1.4%), and pulmonary expansion deficit in 3 patients (4.1%).

Mean WBS pain score was 6.84 ± 1.63 at postoperative hour 2, 4.19 ± 1.36 at postoperative hour 6, and 2.58 ± 1.20 at postoperative day 1. Geriatric patients had significantly higher VAS pain scores at postoperative hour 6 and day 1 (p = 0.011, p = 0.013). There were no statistically significant differences in visual analog scale (VAS) scores according to gender, CCI, operated side, procedure type, or number of ports (p > 0.05). Similar results were obtained in the subgroup analysis of patients with malignant and benign disease, with no significant relationship between VAS score and number of ports or procedure (p > 0.05). No statistical difference was found between the number of ports, therapeutic or diagnostic treatment and postoperative pain scores (p > 0,05). There was a correlation between port size and mean early postoperative pain (r = 0.121). Pain scores of patients in the malignant and benign groups are shown in table 3.

Table 3. Comparison of VAS scores in patients with malignant and benign disease.

Variables	Malignant	Benign	p value
Postoperative 2 hours	7.17±1.65	6.73±1.63	0.715
Postoperative 6 hours	4.33±1.18	4.14±1.42	0.067
Postoperative 1 day	3.11±1.23	2.41±1.15	0.027

Patients with benign disease had significantly higher quality of life compared to patients with malignancy (p < 0.001). No statistically significant differences in quality of life were observed according to gender or type of procedure (p > 0.05). Number of ports had a significant effect on general health perception (p = 0.016), but the impact on quality of life was not significant. The presence of complications significantly affected physical functioning, role limitations due to physical health, role limitations due to emotional problems, energy/fatigue, emotional wellbeing, and general health perception (p = 0.030, p = 0.028, p = 0.028, p = 0.005, p = 0.008, p = 0.024). Patients aged 65 and older showed significantly poorer results in the physical functioning, role limitations due to physical health, role limitations due to emotional problems, energy/fatigue, emotional wellbeing, pain, and general health perception scales (p = 0.05). There was no significant relationship between quality of life and gender, operated side, port location or number, CCI, or procedure type (p > 0.05). Table 4 shows the evaluation of quality of life according to malignant and benign disease.

Table 4. Quality of life according to malignant and benign disease.

	Malignant	Benign	p value
Role limitations due to physical health	16.6±38.3	75±43.6	<0.001
Role limitations due to emotional problems	16.6±38.3	75±43.6	<0.001
Pain	52.5±19.03	73.2±20	<0.001
Social functioning	30.2±19.7	57.9±22.1	1
General health	44.16±23.6	68.5±25.04	0.001
Energy and vitality	30.2±19.7	51.9±22.10	<0.001
Emotional wellbeing	76.6±19	60±22.7	0.003

Discussion

Thoracotomy is recognized as one of the most painful surgical procedures. In particular, early postoperative pain increases complications such as secretion retention, limited physical movement, atelectasis, and pneumonia, while chronic neuropathy reduces quality of life in the long term [7-9]. Stammberger et al. [10] reported that 50% of patients who underwent VATS had no pain at postoperative 2 weeks. In our study, early postoperative pain was less severe in patients who underwent VATS, consistent with the literature. On the other hand, we noted that geriatric patients had significantly more pain at 6 hours and 1 day postoperatively (p = 0.011, p = 0.013). Early postoperative pain was less severe in patients with benign disease compared to those with malignancy. However, early postoperative pain levels were not associated with procedure type, gender, number of ports, and CCI in our study.

In our study, the quality of life of benign diseases was better than malignant diseases. In particular, their emotional, psychological, and physical scores were better than those in the malignant group. In their study on quality of life among patients with lung cancer, Hopkins et al. [11] reported that patients had more pain and mood disorders in the first 6 months postoperatively. However, long-term quality of life was similar in patients who underwent VATS and those who had thoracotomy. In another study conducted with thoracotomy and VATS groups, Wilson et al. [9] stated that VATS patients had better quality of life and less pain, but the differences were statistically nonsignificant. Other authors have expressed contradictory views. Zieren et al. [12] emphasized that postoperative quality of life reached a maximum level by 9 months in patients undergoing VATS and was better than in those who had open surgery. In their prospective study, Dales et al. [13] observed that patients' quality of life decreased in the first 3 months but returned to near preoperative levels 6-9 months postoperatively. Sugiura et al. [14] compared long-term outcomes of VATS and open surgery and determined that quality of life was higher following VATS. In another prospective study, Balduyck et al. [15] analyzed quality of life in patients who underwent lobectomy by VATS or anterolateral thoracotomy and showed that physical functioning at postoperative 6 months was significantly better in VATS patients (p < 0.001).

However, all of these studies involve limitations. The most important of these is that early complications and age were not evaluated with quality of life. In the present study, we determined that complications influenced early postoperative quality of life. Minor complications occurring in the early postoperative period disrupt emotional, psychological, and overall health perceptions. Studies on open heart surgery have revealed no differences in postoperative quality of life between older and younger patients. In a meta-analysis by Shan et al. [16], postoperative changes in quality of life after similar surgeries were equivalent regardless of age, though older patients tended to have more mood disorders. Demmy et al. [17] emphasized that patients aged 75 or older required postoperative rehabilitation and inpatient treatment more often. In our study, geriatric patients reported lower quality of life than the younger patients.

Limitations of the Study

The present study has certain limitations. The study is retrospective and included a small, heterogeneous patient group. Data regarding the patients' preoperative quality of life was not available, and early postoperative quality of life was assessed without considering presence or history of depression and anxiety.

As a conclusion, although VATS patients have less pain and better quality of life in the early postoperative period, patients with malignancy had worse physical, psychological, and emotional state. In addition, geriatric patients and patients with early postoperative complications showed greater decreases in early postoperative quality of life. Therefore, we believe that supportive psychotherapy in the early postoperative period may lead to better quality of life outcomes.

Declaration of conflicting interests

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Original Article

Sustained preservation of pulmonary function after pleurectomy/decortication: should it be the main reason to perform surgery in malignant pleural mesothelioma patients?

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ABSTRACT

Background: Pleurectomy/decortication for malignant pleural mesothelioma is performed to improve survival and pulmonary function. Our aim was to analyze pulmonary function outcomes following pleurectomy/decortication.

Materials and Methods: 95 patients underwent pleurectomy/decortication for mesothelioma between years 2005-2016. 30 patients were alive at the time of analysis. Three patients were not fit to perform spirometry and three patients were living in rural areas. In 24 patients, spirometry was performed and compared with preoperative values. Demographic data, side, surgical technique, histology, recurrence, FEV1 (% and L), FVC (% and L), change in FEV1 and FVC were recorded and analyzed. A control group (n = 9) was formed with lung cancer patients who underwent lower lobectomy.

Results: Average age was 56 ± 10 years (26-75). 13 extended and 11 partial pleurectomy/decortications were performed. Average hospital stay was 6.9 ± 3.4 days. 21 patients had epithelioid and 13 had T3-4 tumors. 23 patients had adjuvant chemotherapy, while 7 had adjuvant high dose radiation. Median survival was 31 months (6.4 - 83). Average preoperative and recent FEV1 (L) were 2.18 ± 0.82 and 1.84 ± 0.61 respectively ($p = 0.004$). The values were slightly higher for lower lobectomy patients. Average percentage change in FEV1 was -11.5 ± 23 which was very similar with control group (-12.4 ± 15). In 6 MPM patients, recent FEV1 (L) was higher than preoperative.

Conclusions: Pleurectomy/decortication results in stable or improved pulmonary function in 40% of the patients independent of survival. The change in FEV1 is identical with lower lobectomy patients. Pleurectomy/decortication should be the preferred technique in resectable mesothelioma patients.

Key Words: malignant pleural mesothelioma, pulmonary function, pleurectomy/decortication

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Introduction

Surgical treatment of MPM has been a controversial topic over the last two decades [1,2]. While the goal of the surgical treatment is often stated as macroscopic complete resection in line with general oncologic resection principles, various techniques evolved to achieve this goal. The most prominent of those techniques is extrapleural pneumonectomy (EPP) which offers the most extensive resection with curative intent, but ultimately long-term data revealed that it often results in increased mortality/morbidity, limited quality of life, inability to complete other treatment modalities and no significant improvement in survival when compared to other modalities [1-5]. EPP also requires a rigorous patient selection criterion, which excludes a large portion of patients with MPM. Pleurectomy/decortication (PD) and extended pleurectomy/decortication (EPD) on the other hand, are usually safe in a wider patient population, results in cytoreduction with lower macroscopic complete resection rates with comparable survival outcomes [1,2,6,7]. PD and EPD also provide a good performance status and quality of life, most likely owing to the preservation of the lung capacity and biological behavior of the mesothelioma [8,9].

Since the fact that justification of surgery in MPM patients relies on preservation of performance status and retaining the ability to follow through multiple treatment modalities and removing maximal tumor burden, long-term pulmonary function data is important. The objective of this study is to analyze pulmonary function over survival time in a cohort of patients who had P/D in our institution for MPM and compare it with a control group of lung cancer patients who underwent lower lobectomy.

Materials and Methods

All patients undergoing P/D for MPM since 2005 were recorded in a prospective database. Information on patient demographics, medical history (comorbidities, previous malignancy etc.), preoperative assessment (PFT, clinical stage, tissue diagnosis etc.), operative outcomes (resection status, pathologic type and stage, complications, length of hospital stay) and postoperative outcomes (additional treatment modalities, survival, follow up pulmonary function tests) were gathered.

All patients with radiologically resectable MPM and no bulky mediastinal or extrapleural lymph node metastasis were evaluated for multimodality treatment. Preoperatively, patients underwent thoracoabdominal CT scan, PET-CT, laboratory and pulmonary function tests and cardiac evaluation. Mediastinal staging was based PET-CT. If there was any suspicious mediastinal lymph node involvement, cervical mediastinoscopy was performed.

Surviving patients at the time of analysis were determined. They were called for a pulmonary function test (PFT). Preoperative and recent PFTs were compared. A control group was formed with non-small cell lung cancer (NSCLC) patients who underwent lower lobectomy through a thoracotomy. PSPP 1.0.0.0 for GNU was used for statistical analysis. Fisher's exact, Chi-Square and Students T tests were used for comparison.

Technique of PD

MPM patients who underwent PD were classified according to the recent recommended nomenclature for mesothelioma surgery techniques [10]. We typically performed the resection through a posterolateral thoracotomy. In all cases, sixth rib was removed. Complete removal of all the parietal and visceral pleura including the fissures was the aim of the surgical exploration.

Results

95 patients underwent PD between years 2005-2016. 30 patients were alive at the point of analysis. Three patients were not fit to follow up due to chemotherapy and 3 were lost to follow up. 24 patients were included in the analysis. 14 patients were found to be surviving beyond 24 months. Four patients had removal and reconstruction of the diaphragm. Average follow up time was 31 ± 20.6 (6.4 - 83) months. Characteristics of patients who underwent PD and lower lobectomy are shown in table 1.

Average preoperative and recent FEV1 of MPM patients were 2.18 ± 0.82 and 1.84 ± 0.61L respectively (Figure 1).

The values in NSCLC patients were slightly higher (Figure 2).

Table 1. Comparison of patients who underwent pleurectomy decortication and lower lobectomy.

	MPM (n=24)	NSCLC (n=9)	P value
Age (years)	56±10	55±14	0.94
Gender (M/F)	14/10	8/1	0.21
Type of Operation	Extended P/D:4 Total P/D:9 Partial P/D:11	RLL:5 LLL:4	
Cell type	Epitheloid:21 Biphasic:3	NA	NA
Macroscopic complete resection (Y/N)	Y:13 N:11	NA	NA
Adjuvant treatment	Chemotherapy:23 Hemithoracic irradiation:7	NA	NA
Average preoperative FEV1 (FEV1%)	2.18±0.82 (77.88±21.13)	2.7±0.5 (83.1±9.7)	0.085
Average recent FEV1 (FEV1%)	1.84±0.61 (68.33±17.95)	2.4±0.8 (75.2±20.5)	0.039
Average % change in FEV1	-11.5±22.7	-12.4±14.9	0.9
Average preoperative FVC (FVC%)	2.77±0.99 (82.75±23.13)	3.5±0.6 (87.5±9.7)	0.036
Average recent FVC (FVC%)	2.29±0.7 (69.33±17.78)	3.29±1.3 (81±27.7)	0.009
Average % change in FVC	-11.4±32.3	-11.9±26.1	0.98
Improvement in PFT (Y/N)	6/18	3/6	0.25
Average follow-up (months)	31±20.6	32.8±20.6	0.97

Abbrev.: MPM: Malignant pleural mesothelioma, NSCLC: non-small cell lung cancer, P/D: pleurectomy/decortication, FEV1: forced expiratory volume in 1 second, FVC: forced vital capacity, PFT: pulmonary function test.

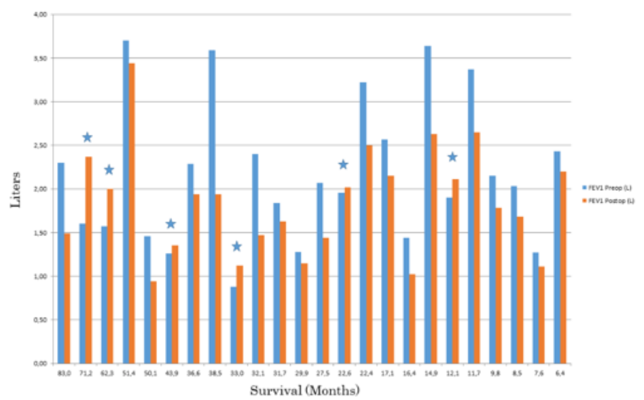

Figure 1. Measured values of FEV1 in each PD patients pre- and postoperatively. Patients with improved FEV1 are marked with a star. Four of 6 patients who had improved FEV1 were survivors beyond 2 years. In 2 additional patients the decrease in FEV1 was less than 10%.

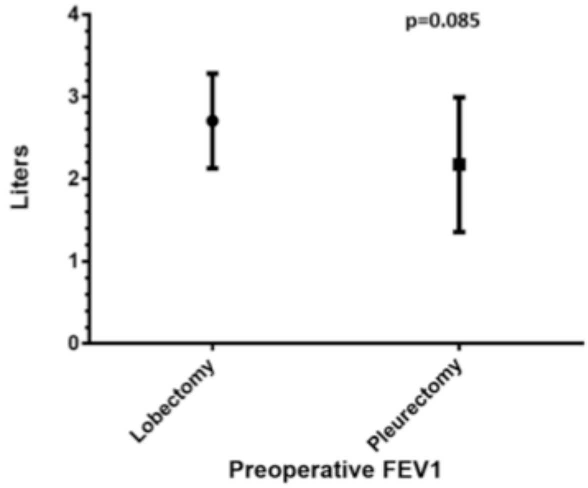

Figure 2. Preoperative FEV1 of PD (n = 24) and lower lobectomy (n = 9) patients. The FEV1 values were 2.18 ± 0.82 and 2.71 ± 0.58 respectively (p = 0.085).

Average preoperative and recent FVC of MPM patients were 2.77 ± 0.99 and 2.29 ± 0.7 respectively. Both were significantly higher in NSCLC patients. FEV1 values were found to be improved in 6 patients who had statistically significant loss of pulmonary function when compared to remaining patients (1.53 ± 0.41 vs 2.39 ± 0.81, p= 0.003).

No statistically significant difference was observed between lobectomy and PD patients in terms change in FEV1 and FVC (Table 1). Both groups experienced almost 12 percent loss in FEV1 over similar mean follow up (Figure 3).

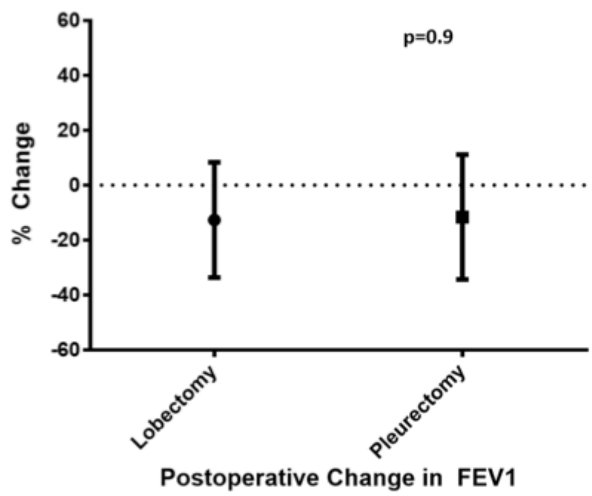

Figure 3. Change in FEV1 in PD (n = 24) and lower lobectomy (n = 9) patients. Average decrease was -11.5 ± 22.7 and -12.4 ± 14.9 respectively (p = 0.9).

Presence of recurrence (n = 9) was associated with a higher percentage of FEV1 drop (-18 ± 13%) when compared with patients who did not have any recurrence (n = 15, -8 ± 7%) (p = 0.33) (Figure 4).

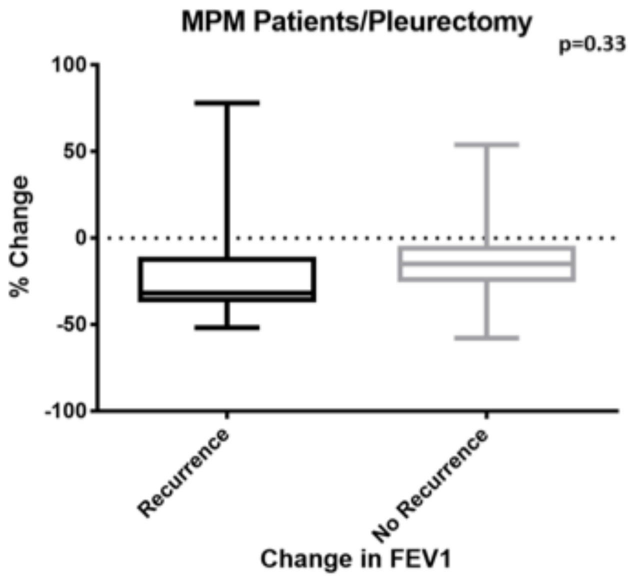

Figure 4. The decrease in FEV1 was more limited in patients without recurrence (-8 ± 7%). In patients with recurrence the decrease was more profound (-18 ± 13). However, the difference did not reach significance (p = 0.33).

The difference was not also significant when two techniques were compared. Total or extended PD (n=13) did not result in a better FEV1, however it can be seen in the scatter plot that it may result in better FEV1 in a larger series (Figure 5).

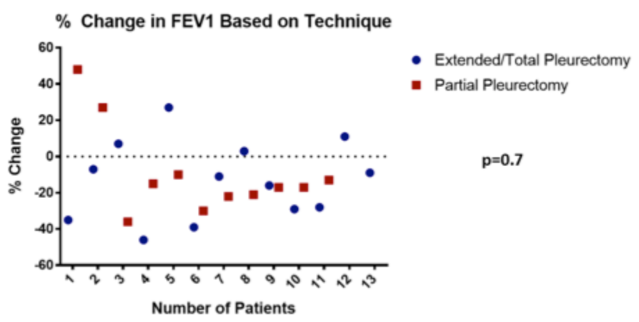

Figure 5. A total of 4 patients with EPD or PD had improved FEV1, compared with only two patients with partial PD. The difference was not significant as well (p = 0.7).

Discussion

Surgical treatment of MPM has been a controversial topic over the last two decades. Even with the multimodality treatment protocols, MPM's prognosis remains dire with median survival just under two years and five-year survival is negligible [11]. Surgery's place in the multimodality treatment protocols has been hard to define due to the small patient pool, variety of techniques and definitions [12]. Moreover, the peculiar biological behavior and spread patterns of MPM renders oncologic surgery with traditional curative intent (R0 resection) technically impossible in many of the cases or it comes at the cost of excessive mortality/morbidity.

Studies focusing on survival also reflect that adoption of less aggressive surgical options sacrificing oncological "quality", even pursuing maximal cytoreduction instead of macroscopic complete resection result in comparable outcomes [1,2]. This concept also applies to a wide patient population, covering the patients who would be dropped as unfit (e.g.: cannot tolerate lung or diaphragm resection). Therefore, the question of how extensive MPM surgery should be remains. This question needs to be examined on two fronts. First is survival, which is comparable to larger case series despite being out of scope of this article. Second is disease specific quality of life, which can be quantified as preservation of pulmonary function in MPM patients.

In patients who underwent extrapleural pneumonectomy (EPP), following initial decrease in quality of life, a stabilization occurred at 6 months postoperatively and after 12 months, progressive deterioration in pulmonary function and quality of life was evident [13]. A study comparing changes in pulmonary function following EPP and PD, showed preservation of pulmonary function following PD, whereas a significant deterioration following EPP (14). Changes in pulmonary function following PD or EPD were analyzed in several studies and are listed in table 2 [9,15,16]. Interestingly improvement in pulmonary function and quality of life following neoadjuvant chemotherapy was associated with radiologic regression of the tumor [17]. A positive change of 7% in FEV1 and 6% in FVC were related with a radiologic partial response.

Table 2. Studies in literature focusing on postoperative pulmonary function following PD.

Authors, study year	n	Surgical technique	Preoperative FEV1	Recent FEV1	Time interval between measurements
Tanaka et al, 2017 [15]	22	PD	2.35±0.59	1.57±0.37	Before discharge
Burkholder et al, 2015 [16]	36	EPD	74.3*	72.6*	5-7 m after surgery
Bolukbas et al, 2012 [9]	16	EPD	1.79±0.45	2.18±0.50	2 m after surgery
Current study	24	PD	2.18±0.82	1.84±0.61	31±21 m. after surgery

Abbrev.: FEV1: forced expiratory volume in 1 second, PD: pleurectomy/decortication, EPD: extended pleurectomy-decortication, m: months
**% FEV1 values. In this study, FEV1 was improved in patients with performance status 1 and 2, whereas decreased in patients with performance status 0.*

In this article, we provide pulmonary function data of long-term survivors of MPM. Prognostic factors other than oncological staging have been studied and validated by many clinics, newer markers are being established. In one report, favorable prognostic factors in 117 (18%) patients who survived longer than 3 years out of 636 patients were analyzed [18]. Those patients were younger, predominantly female, more frequently had epithelioid histology and normal complete blood cell counts. Those factors were validated in other patient pools.

Limitations of the Study

First of all, it is a single institution study that includes limited number of patients treated over more than a decade. 23 out of 24 patients received chemotherapy, which may also have a role in improvement of lung function. The study includes only surviving patients, thus it does not reflect the pulmonary function outcome in patients who had early recurrence and rapid deterioration, but there are patients with limited or extensive recurrence in the patient group. Seven of the 24 PD patients passed away due to progression of MPM after this study. Despite all these limitations, this is the first study in literature that presents pulmonary function data in long-term in MPM patients.

Better preservation of lung function and decreasing actual tumor burden may also help patients to remain fit for treatment methods (chemotherapy, radiotherapy) that they could not receive otherwise. This fact has been demonstrated in our data as well with 25% of survivors still exhibiting improved lung functions and overall PFTs are in line with a control group who has undergone lower lobectomy for lung cancer and facing much better prognosis due to the nature of their disease.

Preservation of pulmonary functions independent of survival in long term survivors is an important fact for choosing maximal cytoreductive approaches (extended/total/partial pleurectomy) over purely palliative ones (videothoracoscopic surgery and talc pleurodesis) and radical approaches on the other end of the spectrum. The goal of non-palliative surgery in MPM should be providing maximal lung expansion via debulking as the benefit of stable or improved lung function is durable over the course of survival in well selected patients.

In conclusion, good candidates for cytoreductive surgery (extended/total/partial pleurectomy) seem to enjoy durable functional benefit beyond 2 years and PFTs results seem to be in line with patients who have undergone lower lobectomy and facing a better diagnosis. Better understanding of prognostic parameters will enable us in selection of candidates for multimodality treatment methods. In the meantime, for good surgical candidates, non-palliative cytoreductive surgery may offer the best chance for long lasting acceptable pulmonary function, enabling them to complete other modalities and enjoy better prognoses.

Declaration of conflicting interests

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Original Article

The role of bronchoalveolar pattern of the former classification in the 8th edition of IASLC-TNM classification.

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ABSTRACT

Background: Until the reclassification by the International Association for the Study of Lung Cancer, the term bronchoalveolar carcinoma (BAC) has been used for many years. Accordingly, the terms BAC and mixed adenocarcinoma were replaced by the terms such as adenocarcinoma in situ, minimally invasive adenocarcinoma, lepidic dominant type adenocarcinoma, mucinous minimally invasive adenocarcinoma, and mucinous invasive adenocarcinoma. The aim of this study was to retrospectively evaluate the cases diagnosed as BAC and mixed type adenocarcinoma operated in our clinic and to compare the clinical and survival characteristics of these cases according to the new classification.

Materials and Methods: 37 patients who were operated in our clinic between January 2005 and December 2014 and diagnosed as BAC and mixed adenocarcinoma containing BAC components were included in the study. Pathologic slides were re-reviewed by the pathologists of our hospital and re-classified according to the predominant histologic subtype. In addition to the predominant cell type, the ratio of other cell types were also specified in 5% ratio slices.

Results: The histopathological diagnoses of 37 formerly BAC patients, 14 of whom were mixed type, were changed as 33 lepidic, two mucinous, one adenocarcinoma in situ and one micro-invasive adenocarcinoma. The 5-year survival rate for lepidic predominant histological subtype was 70.3, while it was 50% ($p = 0.533$) for the two mucinous cases.

Conclusions: The predominant cell type distribution used in the new classification of IASLC is more effective in determining survival and is more suitable for use in treatment and follow-up programs.

Key Words: lung cancer, adenocarcinoma, bronchoalveolar carcinoma, classification, staging

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Introduction

The term bronchoalveolar carcinoma (BAC) was first used by Avril Liebow as in the diagnostic sense in 1960 [1]. This term had served as a subtype of lung adenocarcinoma for decades to the thoracic oncology. However, in 2011, the International Association for the Study of Lung Cancer (IASLC) proposed a new classification of adenocarcinoma and argued that the terms "BAC" and "mixed type adenocarcinoma", which included bronchoalveolar pattern, should not be used anymore due to their broad spectrum [2]. The World Health Organization's new lung cancer classification published in 2015 also included the majority of these proposed changes [3]. Accordingly, the terms BAC and mixed adenocarcinoma were replaced by the terms such as adenocarcinoma in situ, minimally invasive adenocarcinoma, lepidic dominant type adenocarcinoma, mucinous minimally invasive adenocarcinoma, and mucinous invasive adenocarcinoma (Table1). The aim of this study was to retrospectively evaluate the cases diagnosed as BAC and mixed type adenocarcinoma operated in our clinic and to compare the clinical and survival characteristics of these cases according to the new classification.

Table 1. Categories of new adenocarcinoma classification.
Where former BAC concept was used
1. Adenocarcinoma in situ (AIS), which can be nonmucinous and rarely mucinous
2. Minimally invasive adenocarcinoma (MIA), which can be nonmucinous and rarely mucinous
3. Lepidic predominant adenocarcinoma (nonmucinous)
4. Adenocarcinoma, predominantly invasive with some nonmucinous lepidic component (includes some resected tumors, formerly classified as mixed subtype, and some clinically advanced adenocarcinomas formerly classified as nonmucinous BAC)
5. Invasive mucinous adenocarcinoma (formerly mucinous BAC)

Materials and Methods

37 patients who were operated in our clinic between January 2005 and December 2014 and diagnosed as BAC and mix adenocarcinoma containing BAC components were included in the study.

Pathologic slides were re-reviewed by the pathologists of our hospital and re-classified according to the predominant histologic subtype as defined by IASLC/ATS/ERS classification, and recently 2015 WHO classification. In addition to the predominant cell type, the ratio of other cell types were also specified in 5% ratio slices.

Patients were excluded if they had an incomplete resection, metastatic disease or nodule found at the time of surgery.

Before 2010, all patients were evaluated with contrast-enhanced chest computed tomography, and after 2010, PET-CT was added due to its ability to detect unknown metastases. Patients without enlarged lymph nodes and with a PET-negative mediastinum proceeded directly to the surgery. However, patients with enlarged lymph nodes on CT, independently from PET findings, underwent EBUS-TBNA and/or mediastinoscopy. All pathological N2 cases received adjuvant chemotherapy and/or radiotherapy.

From years 2005 to 2010, serratus anterior muscle-sparing thoracotomy was performed in all patients. Since year 2010, almost 25% of patients underwent video-assisted thoracoscopic surgery (VATS).

Medical records of 37 patients were reviewed for clinicopathologic information, including age, gender, smoking history, comorbidity, histologic subtype and, pathologic tumor-node-metastasis (TNM) stage according to the 8th edition of the lung cancer staging system. Patients were followed up at 3-month intervals for the first 2 years and at 6-month intervals thereafter. The date of death was found from the medical records and verified by a software program, linked to the national population registration system.

The study protocol was approved by the local Institutional Review Board (Approval no: 2018/49109414-806.02.02).

Statistical Analysis

Statistical evaluation was performed with IBM SPSS version 21.0 software (IBM Corp., Armonk, NY, USA). Patient survival was expressed by actuarial analysis according to the method of Kaplan Meier, and differences in survival were determined using the log-rank test in the univariate analysis. A multivariate analysis of variables was performed using the Cox proportional odds regression model. For all analyses, $p < 0.05$ was considered as statistically significant.

Results

The mean age of 37 patients, as 25 male and 12 female, was found to be 61.9 (std: 10.0, range: 29-76). The 5-year survival rate was 71.0%, the mean expected survival was 92.5 months (std: 8.4, 76.1-108.8). There was no 30-day mortality.

Survival Analysis

The overall 5-year survival of 37 patients was found to be 71.0%. The number of cases in stages I, II and III were 23 (62.2%), 9 (24.3%), and 5 (13.5%), respectively. 5-year survival in stages I, II, and III were found 76.7%, 87.5%, and 0.0%, respectively. The survival in stage III was significantly worse compared to stage I and stage II ($p = 0.001$, $p = 0.007$, respectively).

The diagnoses of a total of 37 patients, 14 of whom were mixed type, with BAC according to the former classification in our study group, were re-classified as 33 lepidic (89.2%), two mucinous (5.4%), one adenocarcinoma in situ (AIC) and one micro-invasive adenocarcinoma (MIC) according to the new classification of 2015 WHO lung cancer classification. The 5-year survival rate for lepidic predominant histological subtype was 70.3%, while for the two mucinous cases, it was 50% (p = 0.533). The other two patients are still under follow-up.

According to the T factor, 40.6% of the patients (n = 15) had T1, 32.4% (n = 12) had T2, 16.2% (n = 6) had T3 and 10.8% (n = 4) had T4; and 5-year survival was 85.1%, 64.2%, 83.3%, and 0.0%, respectively. There was a significant difference in 5-year survival between only T1 and T4 (p = 0.004).

N involvement was present in three patients (8.1%), as one N2 and two N1. The 5-year survival was 75.1% in patients with N0, while in patients with N positivity, it was 0.0% (p < 0.001). The mean lepidic pattern rate of 33 lepidic predominant patients was 63.3% (range: 40-90) and the median value was 60%. The 5-year survival rate of patients with a lepidic pattern rate of 60% or above was significantly better than those who had below 60% (81.4%, 50.0%, respectively, p = 0.003). In addition, 21 (59.5%) patients had solid components (mean 22.1%, median 20%). The 5-year survival of six patients with a solid component rate below 20% was better than the rest, but it was not statistically significant (60.0%, 50.6% respectively, p = 0.183).

Pleural invasion was present in three patients (8.1%). The 5-year survival of these patients was 66.7%, but there was no significant difference between the other patients (p = 0.379).

Mean clinical follow-up period was 67.5 months (std: 38.9, range: 8-132 months). The last follow-up time was 01.01.2017.

Clinical characteristics and survival of patients are shown in table 2.

Table 2. Clinic characteristics and survival of patients.

Characteristics of patients	Number of patients n (%)	5-Year survival rate (62.2)	Univariate analysis pa value	Multivariate analysis pb value / OR* (CI** 95%)
Age mean 62 (29-76)		76.9	0.625	
<60	13 (35.1)	68.2		
≥60	24 (64.9)			
Gender			0.563	
Male	25 (67.6)	70.8		
Female	12 (32.4)	71.3		
Smoking (mean 60)			0.667	
Yes	22 (59.5)	71.5		
No	15 (40.5)	70.5		
Comorbidity			0.292	
Yes	18 (48.7)	66.6		
No	19 (51.3)	73.7		
Lepidic type rate (%)			0.002	0.009 /21.567
<60	10 (27.0)	50.0		(2.121-219.3)
≥60	23 (73.0)	81.4		
Solid component			<0.001	0.739 /0.808
Yes	21 (59.5)	53.2		(0.231-2.833)
No	16 (40.5)	93.8		
Pathologic stage			0.342	
Stage I	23 (62.2)	76.7		
>Stage I	14 (37.8)	61.4		
Histologic type			0.533	
Lepidic	33 (89.2)	70.3		
Mucinous	2 (5.4)	50.0		
MIC	1 (2.7)			
AIC	1 (2.7)			
N status			<0.001	
N0	34 (91.9)	75.1		
N+	3 (8.1)	0.0		
T factor mean 4.2 (range 0.7-14.0)			0.167	
T1	15 (40.5)	85.1		
>T1	22 (59.5)	61.7		
Pleural invasion			0.379	
Yes	3 (8.1)	66.7		
No	34 (91.9)	71.7		

**OR: Odds ratio, **CI: Confidence interval, pa: Kaplan-Meier Log Rank test, pb: Cox proportional odds model*

Discussion

BAC as a pathological diagnosis describes the spread of adenocarcinoma alongside the alveolar wall. However, this term has now been replaced by a new classification because it is used in a wide range of heterogeneous tumor groups ranging from in situ tumors to invasive carcinomas [4]. In our study, patients with a diagnosis of BAC were re-classified as 33 lepidic, two mucinous and a micro-invasive adenocarcinoma and an adenocarcinoma in situ.

The "lepidic" term is defined as tumor cell growth evenly across pre-existing alveolar structures without involving the papillary or micropapillary structures. Lepidic growth is usually accompanied by thickened alveolar walls, but typically there is no inflammation. In addition, there is no stromal, vascular or pleural invasion [5] (Figure 1).

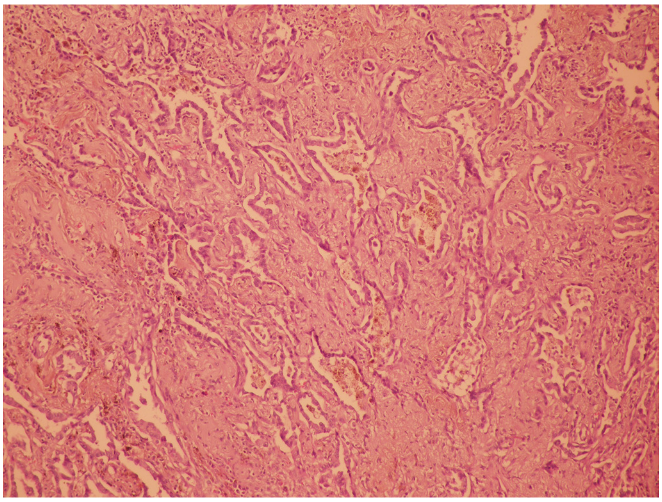

Figure 1. Microphotographs showing lepidic predominat (H&E, x100).

An absolute consensus exists in which lepidic predominant subtype has a better prognosis than other subtypes [5-9]. In our patient group, 5-year survival was 70.3% in lepidic pattern predominant patients, consistent with the literature. Moreover, as many publications in the literature indicate that patients with adenocarcinoma have a better prognosis as the rate of lepidic pattern increases [6,10]. In addition, the higher the rate of lepidic pattern, the lower the possibility of recurrence reported [11]. In our study, mean lepidic pattern rate was found to be 63.2% (std: 17.6, range: 40-100), and the median was 60% in all patients. The cases whose lepidic pattern rate was above 60% had better survival than others ($p = 0.009$). Anami et al. reported that the lepidic component is a more useful prognostic marker than lymph node metastasis [7]. In our patient group, only three patients had lymph node positivity and 2 of them had lepidic and one had a mucinous pattern. Of course, the number is insufficient to reach a conclusion.

Mucinous adenocarcinoma is characterized by tumor cells having goblet cell with abundant intracytoplasmic mucin or columnar cell morphological pattern histopathologically [12]. The prognosis of invasive mucinous adenocarcinoma among invasive adenocarcinomas in the new classification is still controversial. Even though there are studies reporting that mucinous adenocarcinomas are associated with poor prognosis in the literature [8,13], there are also reports that mucinous adenocarcinomas have a better prognosis than nonmucinous adenocarcinomas [14]. All these different results are thought to be due to the fact that mucinous adenocarcinomas constitute only 2-5% of all lung cancers and therefore the number of patients in the studies is low. As in our patient group, the diagnosis of mucinous adenocarcinoma was determined in only two (5.4%) patients.

In conclusion, the predominant cell type distribution used in the new classification of IASLC is more effective in determining survival and is more suitable for use in treatment and follow-up programs.

Declaration of conflicting interests

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Original Article

Rediscovering the legendary treatment of prolonged air leak: therapeutic pneuomoperitoneum

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ABSTRACT

Background: Therapeutic pneumoperitoneum was first described for overcoming pulmonary tuberculosis in the end of 19th century. However, in time, another indication "prolonged air leak" (PAL) after major lung resections, lung volume reduction surgery and decortication operations have come on the scene and this legendary treatment have took place again. Despite the developing technology, medical devices and tools thoracic surgeons still sometimes need to use this treatment to cope with PAL.

Materials and Methods: Twelve patients underwent pulmonary operations were included. Nine of the patients had PAL and three had massive air leak with subcutaneous emphysema in early postoperative period. On mean postoperative 8th day (1-15), a one session pneumoperitoneum was applied. In order to fulfill the vascular bed to prevent from air embolism, all of the patients received 500-1500cc of intravenous saline so that the venous pressure is between 7 and 12.

Results: All 12 patients developed no sequel or chronic complications due to the intervention. Mean hospital stay after the intervention was 8.1 days (2-12), mean chest tube removal time after pneumoperitoneum was 16 days (2-48). Six of the patients were discharged with a complete success (without a chest tube), five patients were discharged with a Heimlich valve and one with passive drainage catheter, but the latter patients were also fully recovered in following days.

Conclusions: In this report, we present 12 cases treated successfully with therapeutic pneumoperitoneum without any severe complications. The unique side of our technique is we used only single application without any need of extra instruments.

Key Words: prolonged air leak, pneumoperitoneum, lung resection

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Introduction

Introducing air into peritoneal cavity to treat a lung disease is a very old procedure, which was first used to treat tuberculous peritonitis in 1890's. But it has begun to be used in the treatment of pulmonary tuberculosis in 1930's [1]. Since the early 1990's, the idea of the use of therapeutic pneumoperitoneum (PP) for the treatment of PAL after lung resections had come on the scene.

One of the most frequent complications after lung resection is PAL. This complication is reported to be seen up to 50% after lung volume reduction surgery [2]. PAL causes longer hospital stay and if present, required adjuvant treatment is delayed because of the undrawn chest tube [3].

In English literature, there are many reports, which describe perioperative and postoperative application of pneumoperitoneum, to cope with present or probable pleural air space problems. While some authors suggest repeated application, our study shows that a single postoperative application with proper technique and timing is enough for a successful treatment [3-8].

There are reports both suggesting intraoperative or postoperative application of therapeutic pneumoperitoneum. In addition, many reports suggest repeated pneumoperitoneum sessions by defined intervals. On the other hand, therapeutic pneumoperitoneum have been described for the residual air spaces or PAL after anatomic lung resections, lung volume reduction surgery and total decortication operations. In this study, we aimed to show the success of just one postoperative application of pneumoperitoneum. What makes our study unique is that it includes different types of resections such as upper lobectomy, lower lobectomy, bilobectomy inferior and also decortication operations performed with either thoracotomy or VATS [9].

Material and Methods

Between January 2015 and August 2018, twelve patients (ten males and two females) underwent pulmonary operations in Ankara Atatürk Chest Diseases and Thoracic Surgery Training and Research Hospital were included in this study. The study protocol was approved by the local Institutional Review Board (642/2019), informed consent was obtained from each patient before the inclusion in the study.

Continuous air leak on postoperative day 5 or further was evaluated as postoperative PAL. Nine patients had PAL and three had massive air leak with subcutaneous emphysema in early postoperative period. Bubble exertion through underwater seal drainage bottle even in rest, without any effort, was defined as "massive air leak". The mean age was 56.8 (18-74). Ten of the patients were operated via thoracotomy while two patients underwent video-assisted thoracic surgery (VATS). There were three lower lobectomy (one right and two left sided), four upper lobectomy (all right sided), two lung volume reduction surgery (LVRS, right and left one each), two total decortication and one bilobectomy inferior operations performed. On mean postoperative 8th day (1-15), under local anesthesia, 1000-1500 cc of room air was introduced percutaneously to left lower quadrant of the abdominal wall, into the peritoneal cavity via a 16 gauge intravenous catheter (Figure 1).

Figure 1. The technique; the left lower quadrant of the abdominal wall is prepared for intervention **(a)**, a 16 gauge intravenous catheter is introduced into the peritoneal cavity under local anesthesia **(b)**.

Figures 2a-c show the chest x-rays of the patients.

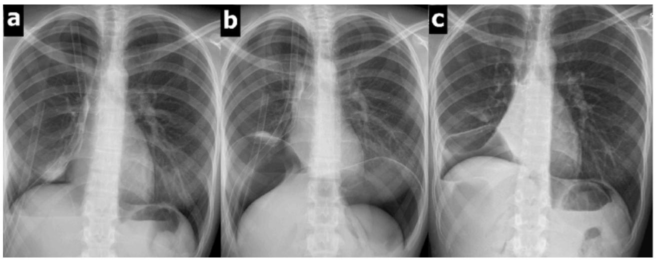

Figure 2. Chest x-rays; before the pneumoperitoneum **(a)**, just after the pneumoperitoneum **(b)**, at the time of discharge **(c)**.

The amount of introduced air was decided by the pain development on the shoulder, which shows the phrenic nerve irritation. The night before the intervention, peripheral venous pressure (PVP) was measured. In order to fulfill the vascular bed to prevent from air embolism, all of the patients received 500-1500 cc of intravenous saline so that the venous pressure is between 7 and 12. Chemical pleurodesis was added to treatment in four patients. While four of the patients had malignant disease the remaining were operated for benign conditions.

Table 1. Patient characteristics, side and type of the resection, histopathologic diagnosis.

Patient	Age	Gender	Surgical technique	Resection	Side	Pathology
p1	59	M	Thoracotomy	LL	Right	Bronchiectasis
p2	53	M	VATS	LVRS	Left	Bullae
p3	71	M	Thoracotomy	Sleeve LL	Left	SCC
p4	48	M	VATS	LVRS	Right	Bullae
p5	64	M	Thoracotomy	UL	Right	Aspergilloma
p6	48	M	Thoracotomy	UL, CWR	Right	OP, DL
p7	74	M	Thoracotomy	UL	Right	Adenocarcinoma
p8	71	M	Thoracotomy	TD	Right	Chronic pleuritis
p9	52	F	Thoracotomy	LL*	Left	AVM
p10	18	F	Thoracotomy	BLI	Right	MEC
p11	47	M	Thoracotomy	TD	Left	MPM
P12	63	M	Thoracotomy	UL**	Right	Adenocarcinoma

Abbrev.: LL: Lower lobe, LVRS: Lung volume reduction surgery, SSC: Squamous cell carcinoma, UL: Upper lobe, OP: Orginizing pneumonia, DL: Destroyed lung, TD: Total decortication, AVM: Arteriovenous malformation, BLI: Bilobectomy inferior, MEC: Mucoepidermoid carcinoma, MPM: Malign pleural mesothelioma,
** Lingulectomy was added, **Chest wall (6th rib) resection was added.*

Table 2. The characteristics of the pneumoperitoneum (PP) intervention.

Number of PP sessions	p1	p2	p3	p4	p5	p6	p7	p8	p9	p10	p11	p12
Volume of air introduced (cc)	1	1	1	1	1	1	1	1	1	1	1	1
Postoperative day of PP application	1000	1150	900	1100	800	1500	1600	900	1000	800	1300	1150
Days of hospital stay after PP	7	11	4	2	1	7	9	9	14	7	15	6
Chest drain removal after PP	6	11	9	14	13	2	4	9	13	10	5	8
	13	16	9	14	13	2	4	26	48	10	22	16

Results

Clinical characteristics of the patients are shown in table 1.

One of the patients had a syncope attack on the time of administration, but he rapidly improved clinically without any further intervention. Thus there was no signs of an air embolism we thought it was a vasovagal syncope. There were no acute complications for the remaining eleven patients. All 12 patients developed no sequel or chronic complications due to the intervention. Mean hospital stay after the intervention was 8.1 days (2-12) and mean chest tube removal time after pneumoperitoneum was 16 days (Table 2).

While six of the patients were discharged with a complete success and without a chest tube, five patients were discharged with a Heimlich valve an one with passive drainage catheter, but the latter patients were also fully recovered in following days.

Discussion

Air leak after pulmonary resection is a widely seen (8-26%) postoperative complication, which causes longer hospital stay and delays adjuvant treatment of oncologic cases. Undoubtedly, the emphysema and the presence of a chronic obstructive lung disease (COPD) are the leading risk factors for PAL after surgery, there are some other risk factors such age, infections, associated interstitial disease, diabetes mellitus, received neoadjuvant induction therapy and malnutrition. Also the intraoperative anatomic conditions such as incomplete fissures and the type of resection (lung volume reduction surgery, upper lobectomy or bilobectomy) is effective in the development of postoperative pleural space problems [6].

Some of the treatment strategies to cope with the residual pleural space or the PAL include pleural drainage with or without suction, pleurodesis, endobronchial one-way valves, pneumoperitoneum and redo surgery [6,7].

Historically pneumoperitoneum as a treatment method of pulmonary tuberculosis was used first in 1930's [1]. Anderson has explained the physiologic aspects of pneumoperitoneum in 1948. An increased intraperitoneal pressure directly transmits to the intrapleural space because of the existing negative intrapleural pressure, thus after only one injection of intraperitoneal air, diaphragm will rise nearly two centimeters [10]. Also Kory and Harden were discussed the physiological effects of pneumoperitoneum widely and they showed that there are no significant negative effects of this treatment on pulmonary and cardiac functions [11,12]. Sure, those days, the most frightening complication of the therapeutic pneumoperitoneum was air embolism. In the report by Atwell et al. it is mentioned that 74 of the 127 cases reported in the literature have been fatal [1]. There are 2 types of air embolism; the pulmonary or venous type and the cerebral or arterial type [13]. In the first type, the site of entry of the air bubble is a systemic vein while in the second type the site of entry is a pulmonary venous channel [14]. A large volume of air is necessary to be fatal in the first type but just a little amount of air may be fatal in the second arterial type. So, one must be careful about preventing to puncture a vascular structure during the intervention. Amar and colleagues have declared that PVP showed a consistent and high degree of agreement with CVP in the perioperative period in patients without significant cardiac dysfunction [15]. In our study, to prevent air embolism, the night before the application we measured peripheral vascular pressure (PVP) of the patients. In order to fill the vascular bed the patient received 500-1500 cc of intravenous saline so that the venous pressure maintained between 7 and 12.

Since the early 1990s, the idea of the use of therapeutic pneumoperitoneum for the treatment of PAL after lung resections has emerged. In a study published by Yusen et al., this method of treatment was reported to be technically feasible [16]. Therefore, in addition to pleural tents, continuous suction drainage, pleurodesis and one-way endobronchial valves; therapeutic pneumoperitoneum has also taken place in the literature in the treatment of long-term air leaks and air spaces. In some of the previous publications, postoperative applications have been reported and in 2003 Toker et al. reported the efficacy of therapeutic intraoperative pneumoperitoneum in patients undergoing lobectomy or bilobectomy for lung cancer [4]. Pneumoperitoneum has been showed to be effective in both apical and basilar space problems after anatomic lung resections and also effective in PAL due to decortication operations and lung volume reduction surgery. Also, intraoperative, postoperative, single or repeated sessions of pneumoperitoneum were all described with their advantages and disadvantages in the literature [2-8,17]. We recommend a single-session postoperative application with an accurate timing. The unique side of our technique is; it does not require neither intraperitoneal pressure measurement nor persistent or adjustable catheters described previously in the literature. Actually only physiologic indicators guide us about deciding the amount of the air we should introduce. First, we take the patient on a supine position. Then, under local anesthesia, a 16 gauge intravenous catheter is introduced into the peritoneal cavity through the left lower quadrant of the abdominal wall (Figure 2). We take care to prevent a vascular injury, and when we are sure that we passed through the peritoneum, we give room air through the catheter. The ending point is the right shoulder pain. When patient describes right shoulder pain, we immediately stop introducing air. The mean air volume we used was 1100 mL (800-1600). The mean increase in the diaphragm was 25.6 mm (8-60) for the right side and 22.1 mm (8-45) for the left side.

If we describe "complete success" as full lung expansion and no chest drain on the time of discharge, then there was a complete success in seven of the patients (50%). But clinically we can also describe discharge with a drainage catheter with or without an Heimlich valve as a "success", because the PAL lead longer hospital stay, secondary infections, hypoxia and need for mechanic ventilation support. In this manner we were "successful" in all 12 patients (100%). 5 patients discharged with an Heimlich valve and one patient discharged with a passive drainage catheter, but for all of the patients full lung expansion was achieved on following days (7-35 days after discharge). There were no serious complications related to the technique on the follow up.

In conclusion, pneumoperitoneum as a treatment choice of residual pleural spaces and PAL after thoracic surgery operations has been described previously in the literature. The physiologic logic and its feasibility were also discussed. Although there are different reports offering intraoperative pneumoperitoneum, there is no report about the physiologic effect of the perioperative administration. On the other hand there are many reports suggesting repeated sessions of pneumoperitoneum. However, our study showed that a single-session postoperative intervention with an accurate timing was also successful. What makes our technique unique is that, we make the intervention as simple as possible. We use only physiologic indicators to decide how much air volume should be introduced. Therapeutic pneumoperitoneum seems to be safe, feasible, and highly cost-effective treatment for PAL and air spaces. Further studies with higher patient sizes should be conducted to prove the effectiveness of this legendary treatment.

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Case Report

A rare cause of chest pain: pleuropulmonary solitary fibrous tumor

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ABSTRACT

A 45-year-old female patient is referred to our service for presenting seven months with left chest pain accompanied by dyspnea. At the chest tomography, a low-density mass with the presence of multiple vascularized septa, without evidence of tumor extension, without mediastinum nodes growth, neither metastatic lesions. The patient was operated with posterolateral thoracotomy. In the exploration, a 10x8x6 cm spherical mass was found which was solid, mobile, with pulmonary apical parenchyma peduncle, and it was totally excised. The postoperative pathology of the patient was reported as a pleuropulmonary solitary fibrous tumor. The management of this case took guidance from the Perrot's recommendations, surgical resection is the mainstay treatment.

Key Words: pleuropulmonary solitary fibrous tumor, solitary fibrous tumor of the pleura, surgical resection, stratification models

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Introduction

The pleuropulmonary solitary fibrous tumor is a mesenchymal origin tumor described by Klemperer and Rabin 1931 [1]. Approximately 900 cases have been documented in the literature up to 2005 [2]. It occurs between 50 to 60 years of age without gender predilection; it is not related to environmental, genetic, and occupational exposure. Its clinical presentation is pleuropulmonary symptomatology and its relationship to paraneoplastic syndromes; 20% pulmonary osteoarthropathy (Pierre-Mary-Bamberger Syndrome) and 5% refractory hypoglycemia (Doege-Potter Syndrome). 80% are benign. The diagnostic approach is with tomography or thoracic magnetic resonance and biopsy, with an immunohistochemistry panel, positive vimetine, CD34, BCL2 and negative keratin [3-9]. The histological dichotomy between benign and malignant should be avoided with the exception of the anaplastic tumor, which has aggressive behavior. Therefore, the malignancy of the solitary fibrous pleural tumor is defined as risk of aggressive or malignant behavior, and this is based on a set of clinical, histological and anatomical criteria, which are calculated with the following behavioral risk stratification models; England in 1989 (1 or more histological criteria), Perrot in 2002 (1 or more histological criteria) and Tapias in 2013 (3 or more of any histological or anatomical criteria). The histological criteria are; > 4 mitoses per 10 fields, Hypercellularity, necrosis, hemorrhage, vascular invasion and / or stroma. The anatomical criteria are; > 10 cm, sessile and parietal pleura [4]. Perrot classifies them as benign peduncle, benign sessile, malignant peduncle, and sessile malignant (Figure 1).

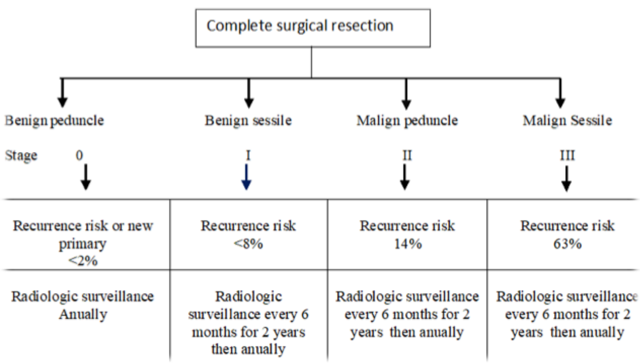

Figure 1. Original modified figure from its publication [5].

Tapias calculates the risk of recurrence with the presence of 3 or more criteria at 3, 5 and 10 years of 20%, 20% and 77% respectively, and 0% with the presence of less than three criteria [6].

Surgical resection is the cornerstone of the treatment, which can be curative if it is an R0 resection [4]. Metastases to liver, lung, and central nervous system are recognized [7]. So that, American Joint Committee on Cancer (AJCC)/ Union for International Cancer Control (UICC), recommends that the pleuropulmonary solitary tumor considered aggressive or malignant be approached with the TNM 8 for retroperitoneal sarcoma staging system [4]. In the case of incomplete surgical resections, postoperative radiotherapy can be offered [5]. However, multimodal or adjuvant therapy is controversial in a pleural solitary fibrous tumor. Therefore, each case must be individualized and treated in a multidisciplinary manner in the case of resection with incomplete margins or a recurrent tumor [4].

In this paper, we evaluated a very rare case of pleuropulmonary solitary tumor with literature.

Case Report

A 45-year-old female patient is referred to our service for presenting seven months with left sided chest pain accompanied by dyspnea on exertion. Chest X-ray evidences tumor located in the apical region of the left lung. The chest tomography reported a 9x8 cm low-density mass with the presence of multiple vascularized septa, without evidence of tumor extension, without mediastinum nodes growth, neither metastatic lesions (Figure 2).

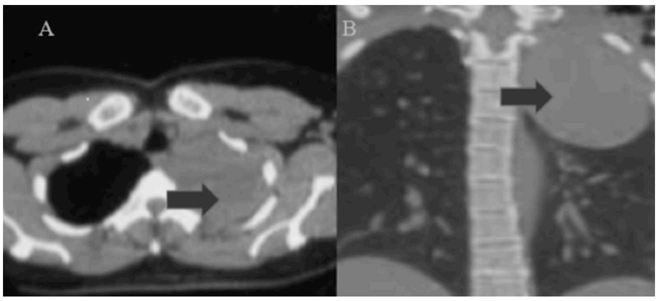

Figure 2. Preoperative chest ray showing a large opacity in the upper left hemithorax **(a)**, computed tomography showing a solid tumor in the upper left hemithorax (**b**).

Transthoracic puncture lung biopsy reported mesenchymal cells compatible with a pleuropulmonary solitary fibrous tumor. Immunohistochemistry was vimentin positive and keratin negative. The patient was informed about the nature of the disease and its corresponding treatment and prognosis, so she accepts surgical resection. A preoperative protocol of pulmonary resection and thoracic surgery was performed. Functional and developmental status, Zubrod 1. Perioperative respiratory low-risk complications and no cardiovascular risk. Thoracoscore 0.1% and The National Surgery Quality Improvement Project (NSQIP) 4.5% risk for perioperative death.

The patient was operated with posterolateral thoracotomy. In the exploration, a spherical mass was found, 10x8x6 cm, solid, mobile, with pulmonary apical parenchyma peduncle with lax adhesions to the mediastinum and anterior endothoracic fascia. Mediastinum without alterations (Figures 3,4).

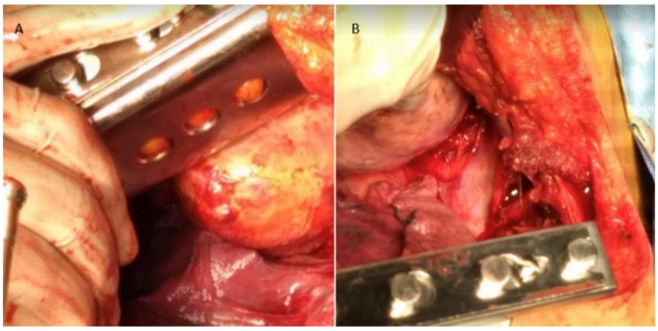

Figure 3. Operative field showing the semisolid mass **(a)**, operative field after complete surgical resection **(b)**.

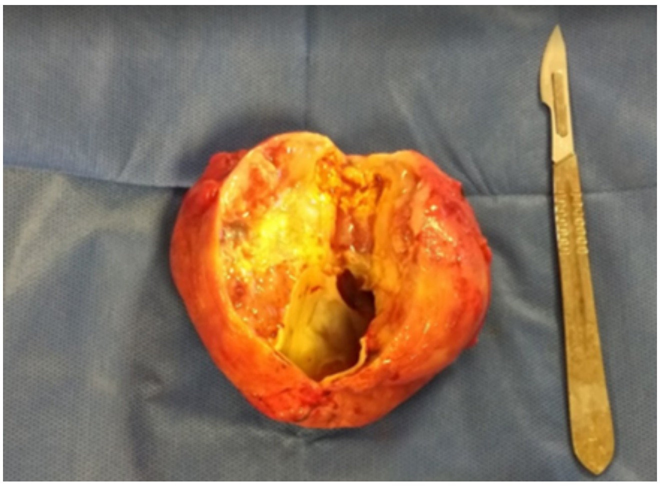

Figure 4. Postoperative image of the surgical specimen.

Mass enucleation was possible without the need to resect lung tissue, structures of the mediastinum neither thoracic wall enblock resection. Hemostasis was verified, and leakage was ruled out, so that the thoracotomy was closed, leaving 32 FR pleural drainage. The patient had a 7-point surgical APGAR score with a 1% risk of complications and a 6% mortality rate. The patient was discharged postoperative 5 day without any complication. The histological report resulted in pleural macroscopic tumor origin, with 10x8x6 cm cystic dimensions with little serous material inside. Microscopically; visceral pleural cells origin with lipomatous characteristics, 2 mitoses per 10 fields, without areas of necrosis, neither stromal invasion. The risk of malignancy or aggressive behavior based on the Tapia model (<3 criteria) was 0%. The follow-up management was based on Perrot's recommendations for benign pedunculated behavior with less than 2% risk of recurrence or new primary tumor, so the radiological control will be every six months for two years and later annually.

Discussion

Female case who presented chest pain and dyspnea as clinical manifestations. We decided to initiate the diagnostic protocol for lung cancer. This behavior was performed because in literature lung cancer has been occurring in people under 65 years of age without risk factors, and the prognosis of early treatment is favorable [8]. We defined pleural solitary fibrous tumor diagnosis, and proceed to a complete surgical resection as the Tapias recommendation [4,5]. We didn't perform bronchoscopy due no tracheobronchial endoluminal alterations were detected at the tomography, neither tumor extension was detected in neighboring anatomical structures or growth of the short axis of the mediastinum lymph nodes.

Surgical resection could be performed without difficulty. Post-surgical results had histological and anatomical criteria for benign mass. We opted for the Tapias model to stratify the risk of aggressiveness because it is the model recommended by the European Journal of Cardiothoracic Surgery, in which the risk of recurrence with less than three criteria, whether histological or anatomical is 0% with a $P < .0001$ [6]. Pleuropulmonary solitary fibrous tumor post-surgical follow-up is similar to lung cancer, which is radiological control every six months for two years and then annually. Post-treatment surveillance is recommended based on clinical and surgical criteria and TNM 8 recommendations [4]. In relation to adjuvant treatment, chemotherapy and radiotherapy have not been demonstrated as alternatives. However, it has been suggested that adjuvant radiotherapy may be an option in incomplete resections [5].

In conclusion, pleuropulmonary solitary fibrous tumor malignancy is based on the prediction of the aggressive behavior of the tumor based on a set of clinical, histological, and anatomical criteria. So that adequate knowledge of this pathological entity is crucial to grant an adequate diagnosis and treatment approach. Complete surgical resection is the cornerstone of the treatment. Multimodal therapy is controversial, and this is not recommended in an R0 resection of the pleural solitary fibrous tumor regardless of its risk stratification, the exception being incomplete resection, recurrence, and the anaplastic histological variant. In this case report, we found a patient with preoperative and postoperative diagnosis solitary fibrous tumor of the pleura benign peduncle. Which was managed with complete resection (R0) of the tumor by enucleation. Perioperative management of standard chest surgery without complications with post-surgical follow-up every six months with chest tomography with low radiation and then annually up to 5 years.

Declaration of conflicting interests

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Case Report

The treatment of foreign body reaction and inflammation caused by prosthetic material with surgery and negative pressure wound therapy

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ABSTRACT

Foreign body reaction and deep wound infection (DWI) following sternal resection and reconstruction represent a serious problem. In recent years, negative pressure wound therapy (NPWT) have been used in clinical practice for treatment of DWIs. However, publications regarding the use of NPWT for the prosthetic material-related inflammation and DWI are yet quite rare. We present a very rare case, which is characterized with foreign body reaction and DWI after sternal reconstruction for a giant chondrosarcoma with the treatment of surgical debridement and NPWT.

Key Words: chest wall reconstruction, sternal wound infection, foreign body reaction, surgery, negative pressure wound therapy

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Introduction

Chest wall resection and reconstruction with prosthetic material will yield satisfactory results in most patients [1]. Sternal wound infections are rare, complicating 4.6% of sternal reconstructions [2]. Their consequences are severe, however, with high mortality, morbidity, and prolonged hospital stay. Chapelier et al [3] reported that required removal of the composite prosthesis with reoperations in four patients (10.5%) for local septic complications. We report a foreign body reaction and deep sternal wound infection (DWI) after sternal reconstruction for a giant chondrosarcoma is treated by using negative pressure wound therapy (NPWT) and surgery.

Case Report

A 46-year-old male was admitted with chest pain and a mass of the anterior chest wall. Computed tomography of chest detected a sternal tumor destroying part of sternum body, which was 6x9 cm in diameter. The patient underwent a radical unblock resection of an 8x11 cm portion of anterior chest wall including the second and third costochondral joints bilaterally, and the tumoral mass with a 2-cm margin of macroscopically normal surrounding tissue. The large chest wall defect was reconstructed with titanium contourable mesh and two titanium straight plates.

Histopathology was reported as low-grade chondrosarcoma. There was no problem in clinical condition, no sign of tumor relapse, the thoracic wall was stable (Figure 1a). One year after the surgery patient presented with DWI. We observed foreign body reaction and skin necrosis (Figure 1b).

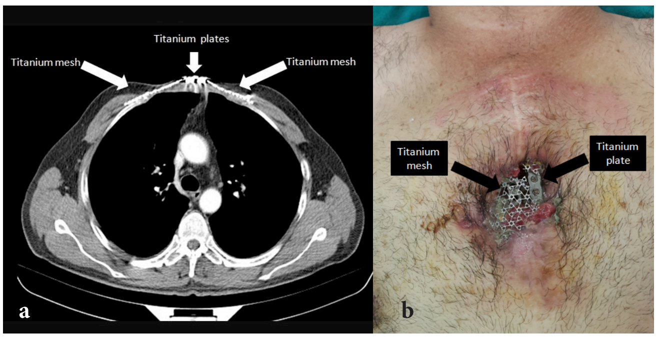

Figure 1. Postoperative chest CT of the patient **(a)**, appearance of the wound one year after surgery (foreign body reaction and skin necrosis) **(b)**.

We performed surgical debridement of necrotic sternum and skin including the previous surgical incision scar and removed the titanium mesh and two plates under general anesthesia (Figure 2a).

The lower and upper portions of the cruciform incision was sutured primarily, and then NPWT was applied to the central area that lost excess skin and tissue (Figure 2b).

Figure 2. Peroperative image showing surgical debridement **(a)**, primary suturation **(b)**, postoperative view (after NPWT the wound was repaired by split thickness skin graft) **(c)**.

We used NPWT for accelerated granulation tissue formation and decreased wound secretion (approximately complete after 6 sessions). During therapy, the maximum negative pressure was kept at 50 mmHg.

After the sufficient thickness granulation tissue formation, the wound was repaired by split thickness skin graft. The patient was satisfied with both cosmetic and functional results. He is healthy without any complaints at one year postoperatively (Figure 2c).

Discussion

Various prosthetic materials have been described to reconstruct large defects of the anterior chest wall, such as polypropylene mesh, metal implants, methyl-methacrylate and titanium plating [3]. It is important to promote good pulmonary function, protect the intrathoracic organs from infection and trauma, and maintain cosmetic integrity. All of these advantageous prosthetic materials might be rejected, displaced or cause septic complications such as foreign body reaction [2]. In such cases, the prosthetic material should be removed. However, this application may not be enough due to the tissue and skin loss. Therefore some studies recommended the concomitant use of the NPWT device allowing the sufficient thickness granulation tissue formation [4]. Nevertheless, the studies comparing NPWT with conventional therapy are all retrospective in nature and reinforce the need for randomized controlled trials in order to more accurately establish differences in outcomes between NPWT and conventional therapy [5]. There are few studies involving the use of NPWT for the prosthetic material-related inflammation and deep sternal infection. In this case, we used titanium mesh for sternal reconstruction. One year after surgery, foreign body reaction and DWI were detected. We initially performed surgical debridement of the necrotic tissue, and then used NPWT treatment to accelerate granulation. Most surgeons now consider NPWT devices to be the first-line treatment for deep sternal wound infection however, we used to NPWT as a bridge therapy to cutaneous reconstruction.

In conclusion, the use of NPWT for the prosthetic material-related inflammation and DWI is very rare. The management and treatment of these cases are difficult and besides surgery, NPWT devices could be used as a bridge therapy. We believe that using NPWT after surgical debridement of necrotic tissue provides healing in a short time.

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Case Report

Chest wall hydatid cyst: a case report

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ABSTRACT

Hydatid cyst is a parasitic disease caused by Echinococcus cestode. Hydatid cyst is an important risk factor in rural areas especially in Mediterranean countries, Middle East and Australia. The disease is most common in the liver and then in the lungs and it is very rare to be seen primarily in the chest wall. We present a 31 years-old female patient with primary chest wall hydatid cyst and discuss the surgical treatment.

Key Words: albendazole, chest wall, hydatid cyst

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Introduction

Hydatid cyst is a zoonotic parasitic disease and Echinococcus granulosus is frequently responsible for this disease [1]. In Turkey, the incidence of hydatid cyst is 2000-2500 cases per year [2]. Cyst formation is the most seen in the liver and it is followed by the lung with a percentage of 10-30% [3]. Although the disease can be seen in different of the body like spleen, kidney, orbit, heart and brain, chest wall is very uncommon localization for this disease [4,5]. This paper is a case report of a 31 years-old female patient with chest wall hydatid cyst without any other organ system involvements.

Case Report

A 31 years-old female patient admitted to the hospital with complaints of chest pain and a mass on the right hemithorax. Physical examination revealed a 4 cm mass on the right chest wall. Thorax computed tomography (CT) revealed a cystic lesion with a diameter of 4x3 cm on the third intercostal space of the right hemithorax without costal destruction (Figure 1).

Figure 1. Thorax CT indicating the cystic lesion in the second intercostal space without costal destruction.

Surgical excision was planned for the exact diagnosis and the treatment. A thoracic incision was made through the third intercostal space, and after dissection of the subcutaneous tissue and pectoral muscles, a cystic lesion of 4x4 cm diameter was visualized between the muscles of intercostal region that was fluctuating on palpation. The ribs were not invaded and the cystic lesion was bulging through the intrapleural space. It was totally excised with blunt and sharp dissection. Cuticular membrane of cystic lesion was confirmed on the specimen. There was no complication postoperatively. Histopathologic examination confirmed that the lesion was hydatid cyst. Albendazole was administered after the operation. The patient was discharged on day 5 uneventfully.

Discussion

Although there are several studies about chest wall hydatid cysts in the literature, primary chest wall involvement is very rare and in most of the patients chest wall was reported to be the secondary place of hydatid disease following the other system involvements [4-6]. In this case, chest wall was considered to be the primary location for the hydatid cyst because no sign of disease was detected elsewhere.

To distinguish of chest wall hydatid cyst from other masses is difficult, as primary chest wall involvement of hydatid disease cannot be considered first by physicians. Chest radiographs usually show us unruptured cysts as round homogeneous well-defined densities but like in the patient reported by Demir et al. the disease can destruct the ribs and can mimic a chest wall tumor [7]. Also CT is not pathognomonic in these patients.

In patients with a history of surgery for lung hydatid cyst, masses of the thoracic wall must be considered as the spread the disease to the chest wall [5]. The pulmonary cysts may rupture spontaneously or during surgery. Rupture of the pulmonary hydatid cysts into the pleural space may contaminate the adjacent organs and this may result to development of pleural or chest wall hydatid cysts. Likewise, in patients with concomitant cystic lesions especially in the lung and liver with the cystic chest wall masses may be considered as clues of the chest wall hydatid cyst. Although in our patient we did not detect a clue considering hydatid cyst, we decided surgery because it would be appropriate for the diagnosis and treatment of this type of cystic lesions of the thoracic wall. In our opinion, percutaneous biopsy is not suitable in such patients due to the risk of rupture of the cyst and dissemination of the infection.

In this case, the intercostal involvement is via systemic circulation i.e. to right heart after passing the common sites, liver and lung. The involvement of body's unexpected portions can be seen rarely with systemic circulation of hydatid cyst [1].

Surgical treatment of the disease is radical removal of involved chest wall. In this case, only the intercostal muscle was involved, therefore the cyst and muscle around it were totally excised. Medical treatment should be used after surgery to avoid recurrences. Albendazole treatment after surgery has a high response rate without recurrence [8]. There are studies that albendazole should be used preoperatively [9]. Although preoperative albendazole treatment can sterilize cyst cavity, it can also cause rupture of the intact cyst and may cause further complications.

In conclusion, hydatid cyst must be considered in the differential diagnosis of chest wall masses when dealing with chest wall tumors even without apparent risk factors. Appropriate treatment of primary chest wall hydatid cyst is surgical excision.

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Case Report

Pneumoretroperitoneum, pneumomediastinum, pneumothorax and subcutaneous emphysema after diagnostic colonoscopy

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ABSTRACT

Colonoscopy is a safe procedure and in less than 1% of the patients, colonic perforation may be seen. Physical examination findings such as pain and distension of the abdomen are well-known symptoms however, dyspnea and tachypnea are seen in only a small number of cases as a sign of iatrogenic colon perforation. In this report, we present a 70-year-old female patient with iatrogenic pneumoperitoneum, pneumomediastinum, subcutaneous emphysema and bilateral pneumothorax after diagnostic colonoscopy. The patient was successfully treated with endoscopic colon repair and left tube thoracostomy. When atypical findings are present such as dyspnea and subcutaneous emphysema, iatrogenic pneumothorax, pneumomediastinum should be kept mind after colonoscopy.

Key Words: colonoscopy, dyspnea, pneumothorax, pneumomediastinum, subcutaneous emphysema

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Introduction

Colonoscopy is a standard diagnostic and therapeutic approach for gastrointestinal tract disorders and the number of colonoscopy use continues to grow rapidly. Colonoscopy is regarded a relatively safe procedure however, complications such as bleeding and perforation can occur. Perforation is one of the most serious complications and its incidence was shown as about <0.005% to 0.65% in the literature [1,3]. Perforation is especially associated with pneumoperitoneum, peritonitis and sepsis in most cases, requires surgical treatment and may be a lethal prognosis in advanced cases [2,3]. Pneumothorax, pneumomediastinum have been reported in few cases [4-6].

In this report, we present a patient with bilateral pneumothorax, pneumomediastinum, subcutaneous emphysema, pneumoperitoneum due to iatrogenic colon perforation during diagnostic colonoscopy. Unfortunately, during the treatment of pneumothorax, an iatrogenic hemothorax also developed all iatrogenic injuries were treated successfully.

Case Report

A 70-year-old female patient was admitted to the hospital with dyspeptic complaints and a moderate anemia (hemoglobin 10.4 g/dL, hematocrit 34.0%). Obesity, diabetes mellitus, suspected liver failure were obtained in her medical history. The patient underwent diagnostic colonoscopy with these findings and a diverticulum was detected in the sigmoid colon. During passing from diverticulum, a small perforation developed and this area was immediately repaired with hemoclips. After colonoscopic procedure, the patient was taken to the intensive care unit. Approximately 6 hours later, the patient described dyspnea. On physical examination, decreased respiratory sounds in the left hemithorax and subcutaneous emphysema on cervical area was obtained. Thorax computed tomography revealed subcutaneous emphysema in the cervical and infraclavicular region, mediastinal diffuse air densities, bilateral pneumothorax (left dominant) and bilateral minimal pleural effusion. Abdominal computed tomography showed diffuse pneumoperitoneum, minimal free intraabdominal fluid adjacent to the liver and density of metallic clips in the proximal part of the sigmoid colon (Figure1).

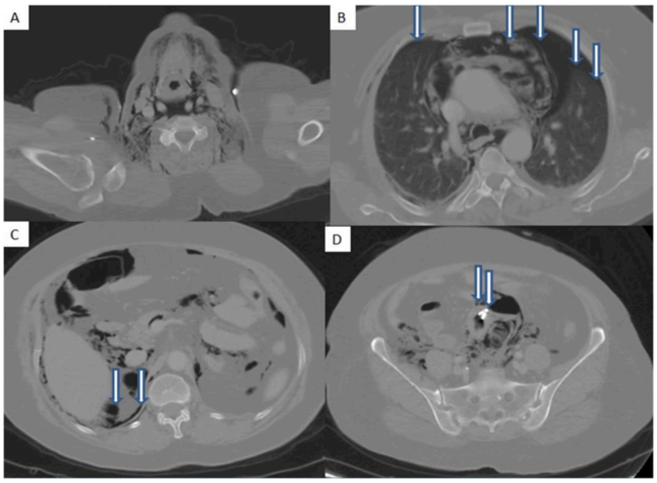

Figure 1. Sections of thorax and abdominal tomography taken after colonoscopy. Subcutaneous emphysema in the cervical region (**a**), pneumothorax and pneumomediastinum (**b**), pneumoperitoneum and air densities in retroperitoneal areas (**c**), opacity of hemoclips which are applied by colonoscopy (**d**).

24F apical tube thoracostomy was performed under local anesthesia for treatment of left sided pneumothorax. The control chest X-ray showed complete expansion of the left lung (Figure 2). Antibiotic treatment was arranged and oxygen therapy was administered by for pneumomediastinum, pneumoperitoneum and subcutaneous emphysema. On the second postoperative day, pleural effusion and subpleural hematoma was seen on the chest radiography and a 32F thorax catheter was inserted to left hemithorax and approximately 500 cc of blood was drained (Figure 2). The patient was followed up on daily chest radiographs, hemogram and C- reactive protein levels.

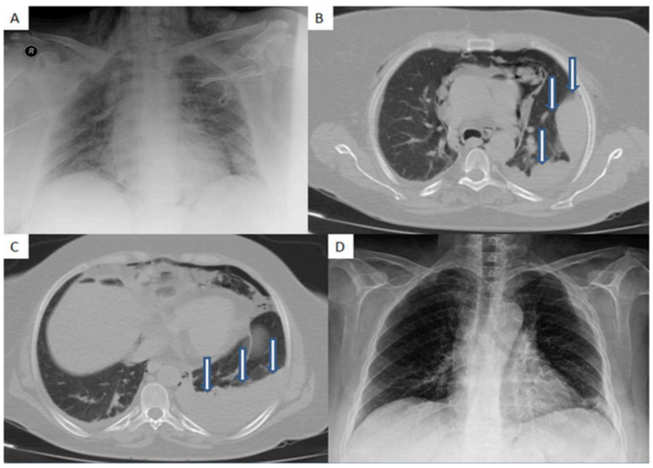

Figure 2. Chest X-ray after tube thoracostomy (**a**), CT image of hemothorax and subpleural hematoma secondary to tube thoracostomy (**b,c**), control chest X-ray taken 2 weeks after discharge of the patient (**d**).

The patient was followed by general surgeons and gastroenterologists on daily bases. Abdominal examination was normal and oral intake was allowed on the 4th day. Apical thorax catheter was terminated on the 3rd day and basal thorax catheter was terminated on the postoperative 5th day. The patient was discharged uneventfully. 6th month follow up of the patient as normal. A written consent form was obtained from the patient for this scientific publication.

Discussion

Colorectal perforation is one of the most serious complications of colonoscopy and usually presents with signs of peritoneal irritation [1-3]. Respiratory pathologies such as pneumothorax, pneumomediastinum and subcutaneous emphysema develop in only a minority of cases [2-6]. In the meta-analysis published by Ajay Gupta et al. [5] iatrogenic pneumothorax following colonoscopy were reported in only 21 cases.

Colonoscopic perforation can occur by various mechanisms; direct mechanical trauma, thermal injury or barotrauma (because of massive air insufflation) [5,6]. Many factors such as old age, female sex, previous abdominal-pelvic surgery, adhesions, diverticulosis, severe colitis, inflammatory bowel disease, malignancy, radiation therapy, low albumin level etc. have been identified for increased risk [1-3,6,7]. Unfortunately, our patient had three risk factor together as; advanced age, colon diverticulum and female sex.

Perforations may be located in the intraperitoneal/extraperitoneal part of the colon, or occur with combination, although clinical signs and symptoms variable according to perforation location [1-3]. When perforation develop in the intraperitoneal part of colon, abdominal complaints may be the first symptoms such as pain, distension or rigidity but, if the perforation is in extraperitoneal part of the colon or rectum, atypical symptoms may develop such as dyspnea, tachypnea and subcutaneous emphysema [1,2,5].

The pathophysiological mechanism of subcutaneous emphysema and pneumomediastinum might be explained due to the presence of a visceral space, which goes from the neck through the mediastinum and retroperitoneum [4-8]. This visceral space follows the trachea and esophagus along the chest and creates a tract for air. The space continues inferiorly through the diaphragmatic hiatus and reaches to the retroperitoneum [4-8]. When air enters the retroperitoneum, it rises by pressure effect along the fascial planes, follows the large vessels, progress through the diaphragmatic hiatus, and reaches to the mediastinum and subcutaneous neck tissues [4-10]. Large amount of air may leak from the mediastinal pleura to the pleural cavity [5,8,9]. Alternatively, free air in the peritoneal cavity may permeate through to intrapleural cavity with small diaphragmatic defects or fenestrations. Air may spread to many places with similar mechanisms, and even cases with atypical findings such as pneumoscrotum have been reported [11].

Clinical suspicion, physical examination and radiologic findings are important in diagnosis. Accompanied by clinical findings, it has been reported that sub-diaphragmatic air in abdominal radiography is an important sign and can be diagnosed in approximately 87% of cases [2]. Chest radiography may also be helpful in cases who present with pneumothorax [3-7]. Abdominal computed tomography may provide information about the location of perforation [1-5].

Early diagnosis of colon perforation is an important issue and it also affects the choice of treatment likelihood; nonoperative management, primary repair, intestinal resection with a primary anastomosis or double stage procedure [2]. In only a rare portion of patients may diagnosed during the procedure like in our case. Corey W et al [2] examined 180 patients who developed colon perforation after colonoscopy and reported 140 of patients were diagnosed within 24 hours. Only 42 patients were diagnosed during colonoscopy. Peritonitis findings may progress and surgical treatment may become more difficult for general surgeons in patients with late diagnosis [2]. It has been reported most of the cases have to undergone surgical treatment and endoscopic repair can be performed in a very limited number of cases in the literature [1,2]. In this case, colonoscopy was performed by an experienced gastroenterologist, perforation was noticed during colonoscopy and repaired with endoscopic hemoclips. The patient was carefully followed up by the general surgery clinic after the procedure and there were no abdominal complaints.

For the treatment of pneumomediastinum and subcutaneous emphysema oxygen inhalation and supportive therapy were preferred in this patient. Since the etiology of pneumomediastinum was known and tracheobronchial injury was not suspected, additional diagnostic procedures such as bronchoscopy were not performed. For bilateral pneumothorax treatment, left tube thoracostomy was used and the patient was followed up with chest radiographs. Unfortunately, an iatrogenic hemothorax also developed in our patient secondary to tube thoracostomy. Therefore, a second tube thoracostomy was performed and the patient was treated without any additional problems.

In conclusion, follow-up period after colonoscopy is an important issue. Abnormal abdominal examination findings such as pain, distention, rebound, rigidity etc. are well known by gastroenterologists and general surgeons. Atypical findings such as subcutaneous emphysema, dyspnea, hoarseness, impaired voice quality may be seen in a small minority of patients. When these atypical findings are encountered, differential diagnosis such as pneumothorax, pneumomediastinum should be kept mind as a sign of iatrogenic colon injury. Cooperation with gastroenterologist, thoracic surgery and general surgery clinics will be effective in achieving successful results.

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Case Report

Novel surgical integration technique in Ravitch procedure using an atraumatic O-ring wound retractor: case report

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ABSTRACT

Modified Ravitch procedure is the hallmark surgical procedure to repair pectus deformities, manual and auto self-retaining metal retractors are very helpful because they grant and maintain the surgical site exposure. However, these metal retractors often have sharp tips that are capable of causing soft tissue flaps damage. In abdominal surgery, using an atraumatic O-ring wound retractor has been associated with diminution of superficial surgical site complications and post-operative pain reduction due, these suggested benefits can be reproducible in modified Ravitch procedure. A 20-year-old male patient is referred to our service for presenting chest discomfort and body image issues. Subsequent work up revealed a pectus carinatum without associated congenital heart disease. A transverse infra-mammary skin 8 cm incision was made. We used an atraumatic O-ring wound retractor to expose surgical site and performed bilateral subperichondrial abnormal costal cartilages resection with sternum wedge osteotomy. Drains was removed in 24 hours, and the post-surgical hospital stay was 72 hours. In this case, using an atraumatic O-ring wound retractor improved exposure with shorter incision, facilitated stable access to the costal cartilage, protecting the skin from injury, and reduced the administration of intravenous analgesics.

Key Words: modified Ravitch procedure, pectus, auto self-retractor, atraumatic O-ring wound retractor, surgical retractor.

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Introduction

Modified Ravitch procedure is the open surgical procedure of choice to repair pectus deformities [1]. The approach can be performed with a transverse or vertical 10 cm incision. Skin and muscle flaps are made elevating pectorals muscles to expose the sternum and bilateral costal cartilages [1,2]. To carry out the surgical correction surgeon hand retractors are used to expose the surgical field, The way it pulls and the force applied cause soft tissue damage [3]. Enhanced recovery program (ERP) is an evidence-based multidisciplinary approach to optimize the recovery of surgical patients in colorectal surgery. Lohsiriwat in 2014 identified soft tissue damage as a comorbid factor that intensifies post-operative pain and cause cicatrisation outcome alteration [3,4]. In 2012 Cheng and Biewenga reported that atraumatic O-ring retractor is a modern self-retaining wound retractor which provides circumferential retraction that causes less tissue damage, thus reducing pain following open surgeries than conventional auto self-retractors [4-6]. Modified Ravitch procedure has been associated to soft tissue complications due extensive dissection and prolonged intravenous analgesia administration for pain management [1,2]. In this case report we describe the use of an atraumatic O-ring wound retractor for modified Ravitch procedure in order to obtain the benefits of the atraumatic device in the thoracic surgery field.

Case Report

A 20-year-old male patient is referred to our service for presenting chest discomfort and body image issues. Subsequent work up revealed a pectus carinatum without associated congenital heart disease. The patient was operated with general endotracheal anesthesia and placement of a thoracic epidural catheter. A transverse infra-mammary 8 cm incision and soft tissue flaps was performed (Figure 1).

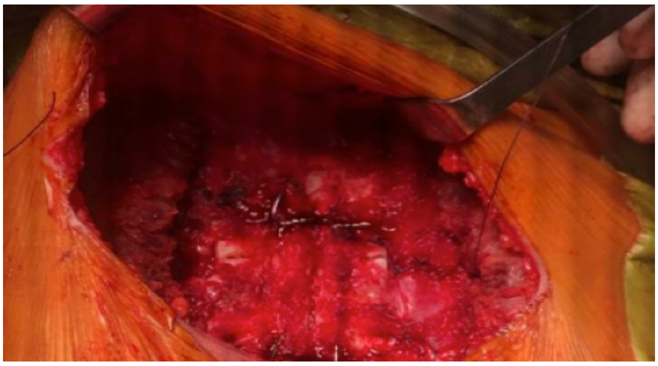

Figure 1. Skin incision and soft tissue flap exposing sternum surgical site.

An O-ring wound retractor was used to expose the affected portion of sternum and bilateral costal cartilages (Figure 2).

Figure 2. Operative field with a traumatic O-ring wound retractor provides 360° of circumferential surgical site exposition.

We found a symmetrical anterior protrusion of the body of the sternum with protrusion of the 4, 5, 6 and 7th costal cartilages. Subperichondrial resection of all abnormal costal cartilages was performed (Figure 3), then we performed a wedge osteotomy to neutralize the posterior depression of the sternum.

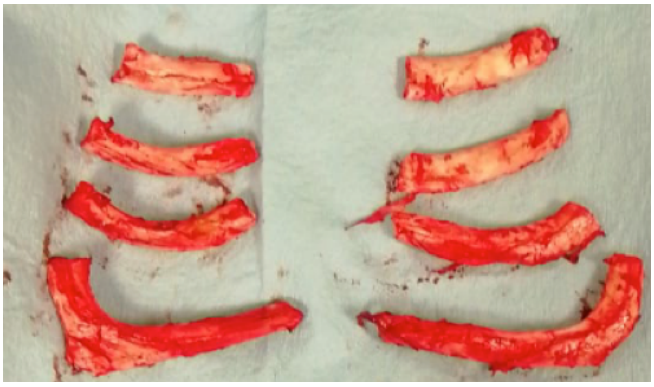

Figure 3. Subperichondrial resection of all abnormal costal cartilages.

Retrosternal and subcutaneous closed drains was placed and soft tissue was closed. Thoracic epidural catheter and drains was removed at 24 hours. Intravenous nonsteroidal anti-inflammatory drugs was switched to oral medication at 48 hours. Patient was discharged under the third post-operative day without complications. Surgery was performed by the thoracic surgery department of Hospital Civil de Guadalajara Fray Antonio Alcalde, Jalisco, Mexico in January 2019.

Discussion

Enhanced recovery program (ERP) identified that tissue damage caused by surgeon hand retractors or metallic conventional self-retaining wound retractor may intensifies post-operative pain and cause cicatrisation outcome alteration [3,4]. Despite the wide dissection needed for soft tissue flaps and the lack of evidence on the utility of the O-ring wound retractor in pectus surgery, we think that its use can avoid soft tissue damage in order to obtain improves in surgical wound management described in abdominal surgery, especially in pain control, and also with the expectative to improve cosmetic scar outcomes. In this case, there were better surgical site exposure that facilitated stable access to costal cartilage resection, protecting the skin from injury during the intervention. We could switch intravenous analgesia to oral intake without the need of opioids with good pain control; this outcome may be attributed by thoracic epidural anesthesia. However we think that the O-ring wound retractor also contributed in pain control, supporting us with Lohsiriwat and Chowdary findings in which they concluded reduction in early postoperative pain and a significant reduction in the amount of intravenous analgesia with the use of an O-ring wound retractor in abdominal surgery [3,6]. The patient was discharged home when the pain was well controlled with oral pain medications (3 days). Subsequent postoperative visit was 2 weeks after surgery without complications (Figure 4), patient referred, no pain, and good satisfaction with the modified Ravitch procedure.

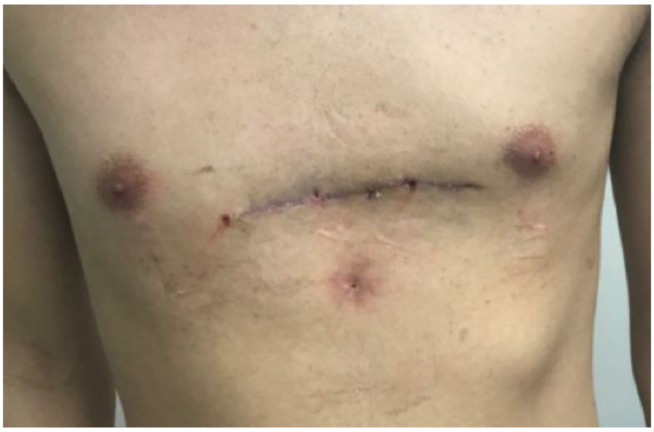

Figure 4. 2 weeks after surgery subsequent superficial surgical site examination.

In conclusion, there is a lack of high quality/high levels of evidence studies that have been conducted on retractors. However, the outcome most commonly documented in relation atraumatic O-ring wound retractor is a reduction in early postoperative pain and superficial surgical site complications. In this case the use of an atraumatic O-ring wound retractor improved exposure with shorter incision, facilitated stable access to the costal cartilage, protecting the skin from injury, and reduced the administration of intravenous analgesics. Studies are needed to support the use of atraumatic retractors in thoracic surgery field.

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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