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ANALYSIS OF LUNG FUNCTION TEST IN PATIENTS WITH PLEURAL EMPYEMA TREATED WITH THORACOTOMY AND DECORTICATION

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A b s t r a c t: The fibrinopurulent phase of pleural empyema has very often been treated with thoracotomy and decortications.

Material and methods: We analyzed the lung function of 19 surgically treated patients in the last 3 years. The lung function was followed up at least 6 months after surgery.

Results: Before surgery the expected mean forced vital capacity (FVC) was 4650 ml, the expected mean forced expiratory volume in the first second (FEV_1) was 3450 ml, the realized mean FVC was 2850 ml, and the realized mean FEV_1 was 1750 ml. The mean FVC 3 months after surgery was 3430 ml, and the mean FEV_1 was 1700 ml. The mean FVC 6 months after surgery was 3850 ml, and the mean FEV_1 was 2950 ml.

Discussion: Early detection and treatment is essential in the treatment of empyema, where the use of thoracic drainage with or without streptokinase or the use of video-assisted thoracoscopic (VATS) decortication were methods of choice in treatment. Later, thoracotomy with decortication was the only treatment solution of the fibrinopurulent phase of empyema, where a trapped lung was frequently detected.

Conclusion: Thoracotomy with decortication is a useful method of treatment of the fibrinopurulent phase of empyema, which solved the problem and also significantly improved lung function, especially at the follow-up after 6 months.

Key words: pleural empyema, thoracotomy with decortication, lung volume analysis.

Background

Pleural affection with infection is the most common complication of the spread of the infection from the infected lung [1, 2, 3]. If we do not recognise and treat it adequately empyema is evaluated in three stages: acute uncomplicated, fibrinopurulent and chronic fibrosing [4]. As at the beginning the treatment of choice is thoracic drainage with or without the application of streptokinase, after that we have to provide VATS decortications, then open (with thoracotomy) decortication and in the end, if any of these is not indicated, we have to employ a thoracoplastic procedure [1, 3, 5, 6]. In the fibrinopurulent phase empyema is very frequently treated with thoracotomy and decortication [7, 8].

Patients with empyema in the fibrinopurulent phase have a purulent collection in the pleural cavity which exerts pressure on the lung. That part of the lung develops atelectasis and changes in the gasses is compromised. At the same time the collection of fibrin on the parietal and visceral pleura develops a fibrosis envelope over the collapsed part of the lung. In the later phase this fibrosis envelope is very fat and the accumulation of fibroblasts between that and the envelop is several millimetres or centimetres fat, and rigid, so that the lung is trapped although the liquid part of the pleural cavity is evacuated [8, 9, 10, 11, 12].

The objective parameters for demonstration of the lung function are lung volume analysis and spirometry. To these may be added analyses of blood gas in patients, and also perfusion and a ventilation scan can be done [8, 11, 12].

The aim of this paper is to analyse the changes in the lung function following spirometry analysis in patients in the fibrinopurulent phase of pleural empyema treated with thoracotomy and decortication.

Material and methods

Over a three-years period (2008–2010 the lung function was analysed with an analysis of lung volume tests in 19 patients who had had surgical treatment at the University Thoracic and Vascular Surgery Clinic, followed up for at least 6 months. two patients with proved specific etiology (tuberculosis)

and one with trauma as the reason for the empyema were previously excluded from the study.

Preoperatively in all patients were provided: chest x-ray, CT of the lung, ultrasound examination of the lungs and pleura, diagnostic thoracocentesis and analysis of the pleural fluid, the standard clinical, bio-chemical laboratory and microbiological findings, lung volume tests, lung gas analyses, and ultrasound examination of the heart. The fibrinopurulent phase of empyema was detected in all patients.

After reanimation and preparation of the patients because of severe intoxication and providing pleural drainage to evacuate the liquid in the pleural cavity, they were treated surgically. Thoracotomy with decortication was performed in all of them. Most frequently posterolateral thoracotomy was done, with saving of the m.m seratus ant., and more rarely posterolateral thoracotomy was performed without saving the m.m seratus ant. The surgery was done under general endotracheal anaesthesia with the provision of two lumen tubes. Affected parietal and visceral pleura were resected and the trapped part of the lung was free to remove completely. If there was a pathological process in the trapped part of the lung (hydatide cist, abscess or fibrosis with infection) they were surgically removed with atypical lung resection ("wedge excision") in healthy tissue. In the end two thoracic drains were placed in the thoracic cavity, which were put on active drainage postoperative. Following surgery a combination of antimicrobial treatment with two antibiotics (ceftriaxone and clindamycin) was provided, or accordingly of antibiogram if the microbiological pathogen was isolated. If complete re-expansion of the lung was not achieved at the end of the surgery, it was continued with a total or partial thoracoplastic procedure and in that case those patients were excluded from the examined group. In the post-surgical period and antimicrobial treatment continued with active reanimation, which depended on the microbiological analyses. In the examined group of patients there was no evidence of death.

Analyses of the lung function were provided at the Pulmology Clinic.

Standard statistical analysis was conducted using the Statistic 11 program, and there was also an analysis of differences in the main values in one group useing the Wilcoxon matched pairs test.

Results

The study included 19 patients treated at the Thoracic and Vascular Surgery Clinic in Skopje who were in the fibrinopurulent phase of empyema, over a three-year period from 2008 to 2010.

The basic parameters of the patients are present in Table 1.

Table 1

Basic dates in patients with pleural empyema treated with thoracotomy and decortication

	Range	Mean
Age	25–61 years	49,08 years
Sex	17 male / 2 female 89,5% / 10,5%	
Side	7 right / 12 left 36,8% / 63,2%	
Diabetes	3/19 15,8%	
Heart failure (decompesation, arrhythmia)	8/19 42,1%	
Positive bacteriology strain	5/19 (26,3%)	
Febrile temperature on hospitalization	5/19 26,3%	
FVC (before surgery)	2120–3470 ml	2850 ml (61,2%)
FEV_1 (before surgery)	1300–3120 ml	1750 ml (50,7%)
Duration of hospitalization	11–100 days	24,15 days
Postoperative days	7–24 days	10,92 days
Used antimicrobial agents	1–3	2,15
Spent units of plasma	1–5	2,54
Spent units of blood	1–5	2,46

Results of the values of forced vital capacity (FVC) and forced expiratory volume in the first second (FEV_1), parameters that presented lung function, restriction and obstructive component are present in Table 2.

Table 2

Dates of spirometry tests in patients with pleural empyema treated with thoracotomy and decortication

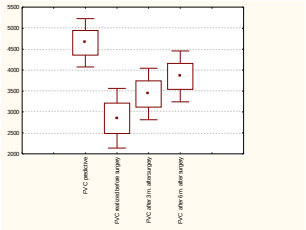
	Expected	Before surgery	After 3 m surgery	After 6 m surgery
FVC	4650 ml *100%*	2850 ml *61,3%*	3430 ml *73,8%*	3850 ml *82,8%*
FEV_1	3450 ml *100%*	1750 ml *50,7%*	1700 ml *49,3%*	2950 ml *85,5%*

Before surgery, the expected mean forced vital capacity (FVC) was 4650ml, the expected mean forced expiratory volume in the first second (FEV_1) was 3450 ml, the realized mean FVC was 2850 ml, and the realized mean FEV_1

was 1750 ml. The mean FVC 3 months after surgery was 3430 ml, and the mean FEV_1 was 1700 ml. The mean FVC 6 months after surgery was 3850 ml, and the mean FEV_1 was 2950 ml. (Table 3 and Graph 1, Table 4 and Graph 2)

Table 3 and Graph 1

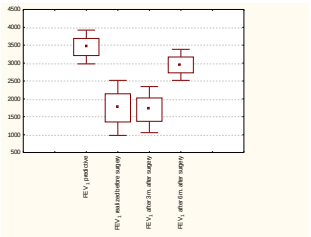
Distribution of FVC in patients with pleural empyema treated with thoracotomy and decortication



	Valid N	Mean	Minimum	Maximum	Std.Dev.
FVC predictive	19	4650,000	4050,000	4990,000	293,9010
FVC realized before surgery	19	2849,737	2150,000	3470,000	363,5797
FVC after 3 m. after surgery	19	3430,000	2820,000	3980,000	313,0850
FVC after 6 m. after surgery	19	3850,000	3300,000	4410,000	310,0717

Table 4 and Graph 2

Distribution of FEV_1 in patients with pleural empyema treated with thoracotomy and decortication



	Valid N	Mean	Minimum	Maximum	Std.Dev.
FEV_1 predictive	19	3450,000	3030,000	3890,000	240,3701
FEV_1 realized before surgery	19	1750,263	1310,000	3120,000	392,4583
FEV_1 after 3 m. after surgery	19	1699,474	1370,000	2900,000	327,7274
FEV_1 after 6 m. after surgery	19	2950,000	2490,000	3450,000	221,6855

The statistical analysis of the results conducted with a comparison of the mean values in the same group presented statistically significant differences between all measured points, and between expected and realized values of respiratory capacity and volumes. Postoperatively, after 3 months and 6 months after surgery there was an increase in the respiratory volumes and capacity both with preoperative values as well as values between themselves with statistical-lsignificance. Spirometry tests after 6 months came closer to those expected with a statistical significance. (Table 5)

Table 5

Compared results of main values of spirometry tests in the different time intervals in patients with pleural empyema treated with thoracotomy and decortication

	Valid	T	Z	p-level	significance
FVC predictive & FVC realized before surgery	19	0,00	3,823007	0,000132	**ss**
FVC predictive & FVC after 3 m after surgery	19	0,00	3,823007	0,000132	**ss**
FVC predictive & FVC after 6m after surgery	19	0,00	3,823007	0,000132	**ss**
FVC realized before surgery & FVC after 3 m after surgery	19	0,00	3,823007	0,000132	**ss**
FVC realized before surgery & FVC after 6 m after surgery	19	0,00	3,823007	0,000132	**ss**
FVC after 3 m after surgery & FVC after 6 m after surgery	19	0,00	3,823007	0,000132	**ss**
FEV_1 predictive & FEV1 realized before surgery	19	0,00	3,823007	0,000132	**ss**
FEV_1 predictive & FEV1 after 3 m after surgery	19	0,00	3,823007	0,000132	**ss**
FEV_1 predictive & FEV1 after 6 m after surgery	19	0,00	3,823007	0,000132	**ss**
FEV_1 realized before surgery & FEV1 after 3 m after surgery	19	25,00	2,437913	0,014773	**s**
FEV_1 realized before surgery & FEV1 after 6 m after surgery	19	0,00	3,823007	0,000132	**ss**
FEV_1 after 3 m after surgery & FEV1 after 6 m after surgery	19	0,00	3,823007	0,000132	**ss**

Wilcoxon Matched Pairs Test. Marked tests are significant at p < ,05000

In all patients preoperative gas analyses were done which showed a reduction of pO_2 with a mean value in the group of 9.7 ± 1.2 kPa, and values of saturation of the blood with a mean value 91% ± 2.3%. These values became normal at the first follow-up one month after surgery.

Postoperatively complications were detected such as: prolonged air leak from the lung 7/19 (36.8%), liquidothorax 7/19 (36.8%), atelectasis 3/19 (15.8%),

pneumonia 5/19 (26.3%), haematothorax 3/19 (15.8%), partial reexpansion 3/19 (15.8%). Some patients had 2 or more complications.

Most of the complications were treated conservatively with prolonged application of thoracic drainage (7/19–36.8%), more intensive physical therapy, prolonged antimicrobial therapy, application of plasma and albumens. Only in one patient (5.3%) was reoperation indicated.

Postoperatively there were no deaths. Postoperative hospitalization was 7 to 24 days (mean 10.92 days).

Discussion

Pleural empyema is mostly a cause of speeding of infection from the lung. This process has several steps, from pneumonia to parapneumonic effusion, uncomplicated empyema, complicated septed empyema and in the end fibrothorax. It is estimated that 10–40% of patients with pneumonia will developed parapneumonic effusion, from which empyema will appear in 10% [1, 2, 3]. In the process of development of empyema, a fibrinopurulent collection is collected on the parietal, and visceral pleura develops a fibrosis envelope. Fibroses of the parietal and visceral pleura, fibrothorax, reduces the respiration of the thorax and at the same time of the lung which is trapped. Proportionally significant are spirometry tests reduced to 50% of the expected [1, 5, 11, 12].

Those processes have been best described by Light RW [2], who divide them into 7 classes, and exactly defined criteria for each of the classes with the suggested treatment for them. In this classification, empyema is in class 4.

Chronic fibrinopurulent empyema according to ATS (American Thoracic Society), described by Andrews [4], are in stages II and III, are conditions when purulent collection with fibrin exists in the pleural cavity which reduces the respiratory function of the lung. In the later process fibroblastic innoculation into fibroses collection trapps the lung and any attempt to remove that fibroses envelope will damage the lung with the possibility of the presence of a prolonged air leak. On the other side, fibroses collections of visceral and parietal pleura are connected with fibroses bridges which make the space like multiple loculated laces with a purulent collection. In this phase the application of thoracic drainage and evacuation of the purulent collection of the pleural cavity is impossible. In these stages it is necessary to evacuate the parietal and visceral pleura by cutting the fibroses bridges, but carefully, to prevent damage to the surface of the lung [1, 3, 5, 6–12].

Exactly these pathological processes are the cause of reduction of the ventilation function of the lung on the first the side where the pathological process is. Pressure on the lung by the purulent collection, atelectasis of the

lung under of it, inflammation, and trapping of the lung are causes of reduced FVC. Pneumonia as a cause of all of these changes is the reason for the appearance of a spastic component with reduction of FEV_1 [8, 11, 12].

Atelectasis of the lung under empyema results in collapse of the alveolar parenchyma, the appearance of a-v shunt with disorders in the changes of the gases, which also results in a decrease in spirometry tests (volumes and capacities) with changes in the gas and acid base status of the blood. These changes were also detected in our study, with a decrease in the values of pO_2 and saturation of arterial blood [8, 11, 12].

Surgical treatment, thoracotomy with decortication, physically removed the problems which are the cause of lung function disorder, so it a better lung function was expected postoperatively, which in fact really did happen. Improving the lung function is not immediate because of pain following thoracotomy. The improvement in lung function is significant and expected 6 months after the operation, when the pain has dispersed [7, 8, 9, 11–15].

Many authors (Metrol [8], Swoboda [11], Witold [12], Ruzman [15] have provided investigations of lung function in patients with decortication. Conducted statistical analysis of the results with a comparison of the mean values in the same group presents statistically significant differences between all measured points, and between the expected and realized values of respiratory capacity and volumes. Postoperatively, 3 months and 6 months after surgery there were increasing of respiratory volumes and capacities both with preoperative values and as values between themselves with a statistical significance. Spirometry tests after 6 months came closer to the expected, with a statistical significance. Our results correspond with those of other studies by other authors. Ruzman refers to FVC increasing from 63% to 79.8% and FEV_1 increasing from 50% to 69%; Metrol refers to FEV_1 increasing from 61% to 79% and FVC from 61% to 77%. The percent of increase in the spirometry tests was dependent on the reason for the empyema (nonspecific and specific inflammation), the time after the beginning of symptoms, the extent of the pathological process in the lung, and other reasons. This is why surgical treatment of the chronic phase of fibrinopurulent empyema is indicated.

In the last 10 years there have been many papers describing decortication done with VATS. In these the investigations of lung ventilator function are compared in VATS and open surgical decortication [16–32].

In our study we have excluded patients treated with VATS because of the limited number of patients. Mostly, open surgery treatment was indicated because of the advanced stage of the empyema with massive fibrinopurulent accumulations. This is also the reason for the conversion of VATS to open decortication from 3.5 to 40% in different studies [16–32]. Early detection of the fibrinopurulent stage of empyema will provide more frequent realization

VATS decortication where several intrathoracic manipulations of the instrumentwill easily remove fibrous accumulations and free the lung (early decortication), when the lung will not be damage [33]. Also early decortication in children will be better provided with VATS [22].

Authors who recommend VATS decortication suggest that if it is necessary to implicate a muscular flap or if a bronchopleural fistula exists or it is necessary to realize complicated decortication, it is better to perform classic open decortication [17, 27, 28].

Conclusion

It is estimate that 10–40% of patients with pneumonia will developed parapneumonic effusion, from which empyema will appear in 10%, so if there is a failure of the treatment of pneumonia we must bear in mind that parapneumonic effusion is a possible complication. Parapneumonic effusion and empyema need to be diagnosed and treated as soon as possible. Early diagnosed empyema can be treated with drainage, but if it is not diagnosed in time it has to be treated with decortication or thoracoplastic surgery in the later stages.

In our study, following decortication,the was an increase in FVC from 61% to 82% and from 51% to 85% in FEV_1 from the expected values for that population.

Thoracotomy with decortication is a useful method of treatment of the fibrinopurulent phase of empyema, which solves the problem and also significantly improves lung function, especially at follow-up after 6 months.

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Резиме

АНАЛИЗА НА ФУНКЦИОНАЛНИТЕ ТЕСТОВИ КАЈ ПАЦИЕНТИ СО ПЛЕВРАЛЕН ЕМПИЕМ ТРЕТИРАНИ СО ТОРАКОТОМИЈА И ДЕКОРТИКАЦИЈА

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Фибринопурулентната фаза на плевралниот емпием многу често се третира со торакотомија и декортикација.

Материјал и методи: Ја анализиравме белодробната функција преку анализа на вентилационите проби кај 19 пациенти хируршки третирани на Универзитетската клиника за торакална и васкуларна хирургија во период од 3 години (2008 до 2010). Белодробната функција беше следена најмалку 6 месеци постоперативно.

Резултати: Пред операцијата очекуваниот среден форсиран витален капацитет (FVC) беше 4 650 ml, очекуваниот среден форсиран експираторен волумен во првата секунда (FEV_1) беше 3 450 ml., реализираниот среден FVC беше 2 850 ml, и реализираниот среден FEV_1 беше 1 750 ml. Средниот FVC по 3 месеци по операцијата беше 3 430 ml, а реализираниот среден FEV_1 беше 1 700 ml. Средниот FVC по 6 месеци по операција беше 3 850 ml, а реализираниот среден FEV_1 беше 2 950 ml.

Дискусија: Раната детекција и третман на плевралниот емпием е посебно значаен во третманот на емпиемот, каде што употребата на торакална дренажа со или без употреба на стрептокиназа или употреба на видеоасистирачка торакоскопска (ВАТС) декортикација во најраната фаза на фибрински налепи се методи на избор. Подоцна употребата на торакотомија и декортикација се единствената солуција на третман на фибринопурулентната фаза на плевралниот емпием, каде многу често се детектира заробен бел дроб во оклоп од фиброза.

Заклучок: Торакотомијата со декортикација е корисна метода во третманот на фибринопурулентната фаза на емпиемот, која го решава про-

блемот на емпиемот, но воедно значајно ја подобрува белодробната функција, изразена преку вентилационите проби, особено на контролата по 6 месеци.

Клучни зборови: плеврален емпием, торакотомија и декортикација, вентилациони проби.

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