ORIGINAL ARTICLE

Use of chest CT scan scoring system for diagnostic and therapeutic decision making in pleural effusion

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ABSTRACT

Aim To investigate the usage of chest computed tomography (CT) scan score for improvement in diagnostic and treatment efficacy of repetitive pleural effusion.

Methods CT scan scoring system was used as a part of diagnostic procedures in patients with repetitive pleural effusion. Patients with at least two pleurocentesis were included in the study. Chest and abdominal ultrasound, chest x-ray, bronchoscopy, biochemical, microbiological and cytological analysis of pleural fluid specimen were performed for all patients.

Results In a two-year period (during 2017-2018) 79 patients were analysed, 27 (34.17%) female and 52 (65.82%) male patients. Malignant pleural diseases were confirmed in 32 cases (40.5%), non-malignant pleural effusions in 38 (48.1 %) cases, and nine (11.4%) patients rested without exact cause of pleural effusion after two pleurocenteses. Binary regression model showed odds ratio of 1.314; CI 95% 1.119-1.543) (p=0.00088). Confirmed malignancies with pleural effusion were in high correlation with the number of points in CT scan score.

Conclusion CT scan scoring system was helpful for diagnostic and treatment decision making in patients with repetitive pleural effusion.

Key words: CT scan, malignancy, pleural effusion, scoring system

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INTRODUCTION

Pleural effusion is very common in everyday clinical practice. It is one of the most challenging problems in pulmonology clinical practice. Up until today it has rested as an unsolved clinical condition. According to the literature up to 30% of pleural effusions remain etiologically undiagnosed without surgical procedure (1). The most appropriate is video assisted thoracoscopy (VATS) (2). Well-defined diagnostic and treatment guidelines include -chest x-ray, chest ultrasound, bronchoscopy, chest CT scan. Formerly chest CT scan score was established to help decision making for diagnostic and treatment purposes (3).

Because of a widespread differential diagnosis and possible overlap of two or more causes of pleural effusion diagnostic approach should be made very carefully (4).

Diagnostic procedure may include a lot of challenges, sometimes an overlap of two or more causes of the development such as inflammatory lung and pleural diseases, with or without infection, pulmonary embolism, pleural tuberculosis and connective tissue diseases, malignant tumours of the lung and pleura, metastatic tumours of distant localization, and many others (5). Criteria for distinguishing exudates from transudates are quite pre-exaggerated, but there are numerous borderline cases (6). After the use of numerous diagnostic procedures as many as 30% of pleural effusions remain unclear and sometime need more aggressive methods (7, 8, 9). Among them, however, is the least aggressive procedure of video assisted thoracoscopy (VATS) (10). Uncertainty for precise diagnosis may be the reason for establishing more aggressive approach in the early phases of treatment of pleural effusion (11). One of the most commonly used diagnostic procedures, which is also in many cases used as a helpful method in decision making of treatment, is chest ultrasound (12). Repetitive pleural effusion is one of the most common diagnostic and therapeutic challenges. There are a few chest CT scan scoring systems for distinguishing different cases of pleural effusion. Two of them are used in clinical practice: one for differential diagnosis of malignant pleural effusion (8) and the other one for distinguishing inflammatory pleural effusion from others.

All scoring systems were established to improve diagnostic efficacy in repetitive pleural effusions without etiologic diagnosis.

The aim of this study was to examine the usage of chest computed tomography (CT) scan score for improvement in diagnostic and treatment efficacy of repetitive pleural effusion. We choose the scoring system for differentiation of malignant pleural effusion from others, because of that non inflammatory repetitive pleural effusions are the most common challenge in everyday clinical practice.

PATIENTS AND METHODS

Patients and study design

A retrospective observational study of patients with pleural effusion treated during the period from January 2017 to December 2018 in the Department of Pulmonology, General Hospital Tešanj was performed. The study involved 79 patients, 15-80 years old, for whom ultrasound guided pleurocentesis was performed with complete biochemical and microbiology tests, Bacil Koch in direct smear (BK) and cytology analysis. Biochemical analysis of pleural fluid specimen was performed for all patients. Patients with transudate were excluded from the study. All patients had recurrent pleural effusion (Figures 1, 2) and pleurocenteses were performed at least two times for every patient. Inclusion criteria were repetitive pleural effusion without exactly confirmed diagnosis. Exclusion criteria were repetitive pleural effusion in heart failure and end-stage renal disease without concomitant diagnosis. Chest x-ray was performed before pleurocentesis, and two hours after the procedure to check for the presence of artificial pneumothorax (as the most common complication of pleurocentesis). Pleurocenteses were performed after an ultrasound examination and with ultrasound guided puncture needle.

Among two dialyzed patients patientpleural empyema was confirmed in one patient, and in the other one the non-small cell lung carcinoma (NSCLC) was confirmed. None of them was included in the study because of concomitant disease with the terminal renal failure with dialysis treatment.

Methods

For all patients the chest x-ray was performed at the time of admission to hospital.

Routine laboratory examination included sedimentation rate (SE), blood count, total plasma proteins, albumin and globulin, C-reactive protein, blood urea and creatinine, blood gas analysis.

Pleural fluid specimen was analysed according to precisely established protocol including biochemical analysis and cytology examination (by experienced pathologist) in order to examine the presence of malignant cells. Microbiological analyses for non-specific infections, BK analysis (direct smear microscopy and Lowenstein culture) were performed. Other examinations were performed according to clinical status and previous diseases.

Chest and abdominal ultrasound and bronchoscopy were performed for all patients. In the cases where CT scan showed possible visible tumour, control bronchoscopy was performed however, in some cases, there was no pathohistological conformation in biopsy specimen. If the chest CT scan was highly suspected for lung neoplasm in the first CT scan imaging, without pathohistological confirmation, control chest CT scan was performed after two months.

Chest CT scan was performed with contrast except for the patients with impaired renal function, calculated by the renal clearance equation with method of the Modification of Diet of Renal Disease (MDRD) if creatinine clearance was below 45 mL/min.

Chest CT scan was evaluated according to the previously described criteria (13-15) (Table 1). CT scan predicting score >7 determined very suggestible malignancy. Volume (measured in mL) of the present pleural effusion was determined by ultrasound measuring a relative distance (in mm) between visceral pleura and the chest (16) (Table 2).

Table 1. Chest CT scan prediction score for determination of malignancy in patients with suspected malignant pleural effusion

CT findings	**Score** (points)
Pleural lesion (nodule, mass or thickening) ≥ 1 cm	5
Lung mass or nodule ≥ 1 cm	3
Abdominal mass	3
Liver metastases	3
Absence of pleural loculations-separations	2
Absence of cardiomegaly	2
Absence of pericardial effusion	2

Table 2. Relative distance between visceral pleura and the chest wall in consideration of pleural effusion volume

Maximal distance between the chest wall and pleural effusion (mm)	**Considered equivalent volume (mL)**	**Variable range (mL)**
0	8	0-100
5	80	20-170
10	170	50-300
15	260	90-420
20	380	150-660
30	550	210-1060
40	1000	420-1670
50	1420	650-1840

Statistical analysis

Analysis was performed using descriptive statistics (frequency analysis), distribution and correlation of confirmed results of malignancy with the calculation of chest CT scan score. Correlation between the number of points in CT scan calculation score and malignancy appearance was determined using binary logistic regression analysis.

RESULTS

Among 79 patients there were 27 (34.2 %) female and 52 (65.8%) male. Average age was 63 years (SD=14.4). For every patient at least two pleurocenteses were performed. Two paracenteses were performed in 56 (70.9 %) cases, three were performed in 11 (13.9 %), four or more paracenteses were performed in 12 (15.2 %) patients. More than two paracenteses were performed mostly for patients with cancer. For eight patients with malignant effusion pleurodesis was done. A number of paracentesis more than four could not be exactly determined, because there were no exact data for paracenteses after the last discharge from our hospital. Paracenteses performed before the first admission in our hospital and noted in discharge letter were counted.

Malignant pleural diseases were confirmed in 32 (40.5%) cases, non-malignant pleural effusions in 38 (48.1%) cases, and nine (11.4%) patients rested without exact cause of pleural effusion after two pleurocenteses.

Primary malignancy in the chest organs (lung, breast, esophagus, pericardium) were found in 23 (out of 32; 40.5%) patients. Confirmed primary malignancies in other organs were found in six (18.8%) patients, two (6.3%) patients had lymphoma or leukaemia as primary malignancies, in one (3.1%) patient with lung metastases primary cancer was not found.

Among 32 patients with confirmed malignancies the most common was breast cancer, in eight (10.1%) cases, followed by NSCLC in two (2.5%). In one case lung metastatic carcinoma was confirmed, but the primary site of carcinoma remained unknown.

Non-malignant pleural effusion was found in 38 (48.1%) cases with confirmed diagnosis. Out of all non-malignant pleural effusion infective pleural effusion, excluding TB, was found in 21 (27.6%) cases; among them 16 (21.5 %) cases with confirmed pleuropneumonia without suppurative complications, and two (2.5 %) cases with confirmed empyema; three (3.8%) cases had pneumonia with suppurative complication. In six patients (7.6%) non-infective pleural effusions was found caused by systemic connective tissue diseases. In 11 (13.9%) cases specific pleuritis was confirmed. In nine (11.4%) cases etiological diagnosis was non-confirmed (Table 3).

Table 3. Distribution of patients according to confirmed or unconfirmed diagnoses

Diagnosis	No (%) of patients
Malignant diseases with pleural effusion	
Carcinoma bronchi (NSCLC)	11 (13.9)
Carcinoma microcellular	2 (2.5)
Adenocarcinoma bronchi	1 (1.3)
Carcinoma mucinocellulare	1 (1.3)
Carcinoma metastaticum pulmonis	1 (1.3)
Lymphoma malignum	1 (1.3)
Chronic lymphocytic leukemia (CLL)	1 (1.3)
Carcinoma mamae	8 (10.1)
Ring cell carcinoma peritonei	1 (1.3)
Carcinoma hepatis	1 (1.37)
Tumor stromalis hepatis	1 (1.3)
Carcinoma vesicae felleae	1 (1.3)
Carcinoma renis	2 (2.5)
Confirmed malignancies	32 (40.5)
Non-malignant diseases with pleural effusion	
Pleuropneumonia	16 (20.3)
Pneumonia abscedens	3 (3.8)
Pleuritis exudativa specifica (TB)	11 (13.9)
Usual interstitial pneumonia (UIP)	1 (1.3)
Empyema pleurae	2 (2.5)
Mixed connective tissue disease	1 (1.3)
Granulomatosis Wegener	2 (2.5)
Granulomatosis non specificata	1 (1.37)
Asbestosis pleurae	1 (1.3)
Confirmed non-malignant diseases	38 (48.1)
Unconfirmed diagnoses with pleural effusion	9 (11.4)
Total	79 (100)

Calculation of CT scan score showed 1-5 points in 15 (19.0 %) cases; borderline with six points was found in 23 (29.1%), score between 7-10 points in 24 (30.4%), score 11-16 in14 (17.8%) patients; score more than 17 was found in three (3.8%) cases.

Binary regression analysis of correlation between confirmed malignant tumours and chest CT scan score showed the odds ratio of 1.314 (CI 95%; 1.119-1.543) (p=0.00088). It is confirmed that malignancies with pleural effusion were in high correlation with CT scan score.

DISCUSSION

Here we analysed patients with two or more performed pleurocentesis as a consequence of repetition of pleural effusion, with or without previously confirmed diagnosis, by which pleural effusion could be explained. Among the patients with confirmed malignancies, the most common was non-small cell lung cancer (NSCLC), followed by breast cancer. In one case metastatic lung cancer was confirmed, but the primary cancer site was unknown.

Undiagnosed recidivate pleural effusion is one of the most important challenges in pulmonology. Ultrasound is largely used for diagnostic purpose in pleural and lung pathology (16) because the tumour or other pathology mass is in touch or near the thoracic wall. On the other hand, endoscopic ultrasound helps to diagnose changes near bronchial tree, and because of the proximity of pathological changes of the bronchi wall it is of crucial importance (17). Ultrasound is one of the most important tools in clinical decision making, both in chronic conditions and in emergencies (18). In addition to improving the use of ultrasound in emergencies, a BLUE (Bedside Lung Ultrasound in Emergency) system was established (19, 20). Normally some fluid is present in pleural space, around 5-15 mL. Sometimes very small amount of pleural effusion can be detected (21). It is known that ultrasound is more sensitive than chest X-ray for detection of pleural effusion. Cutoff amount is 100 mL and 300 mL of pleural fluid respectively (22).

A low frequency ultrasound probe (2-5 MHz) is in the routine use. It is more appropriate for the presentation of deep structures, which is a common situation with pleural effusion. As much as 10-15 cm deep pleural fluid can be visible (23). High frequency ultrasound transducer is more precise, but only structures in 2-4 cm distance can be visible (24).

Some limitation in use of chest ultrasound should be noticed. It is very important to know the ultrasound characteristics of chest and lung tissue.

Physiologic thickness of parietal and visceral pleura is 0.2-0.3 mm. Pleural thickness of 10 mm or more is suggestible to malignancy (25).

Simple or complex pleural effusions could be seen according to echo-sonographic appearance. Simple pleural effusion is low echoic. Complex pleural effusion is with appearance of septation or more heterogeneously echogenic. Hyperechogenic fluid without septation is suggestible for cellularity in fluid, sometimes red blood cells or leukocytes in pleural empyema are present. Septation of fluid is present in long duration of pleural effusion or repetitive pleurocentesis (26). Ultrasound and CT chest scan are together complementary for diagnostic purpose and thereafter decision making for optimal treatment. Sometimes curative, sometimes palliative.

There are a few scoring systems for the purpose of differential diagnosis of pleural effusion. Others calculate tumour size, location and heterogeneity of tumour mass. Undoubtedly CT scan score is useful for differential diagnosis of pleural effusion (27).

Pleurocentesis is the most commonly used procedure in the management of malignant pleural effusion (28). It is recommended to take out no more than 1500 mL to avoid "ex vacuo" recidivate of pleural effusion. If there is no more than one pocket of effusion, without barriers the procedure is very easy. If there is more than one pocket, the procedure can be repeated. Relative risk is very low for complications; pneumothorax was registered in less than 2% of cases (2). On the other hand, it is very important to choose the most appropriate treatment for pleural effusion. In many cases the treatment was just palliative, but it improves quality of life with malignant diseases. Modalities of treatment are limited, and in strong relationship with patients' general condition, confirmed diagnoses with malignancy or without, concomitant diseases and so on (29,30). In all stages of malignancy, a lot of palliative care treatments are performed. Repetitive pleural effusion is the most common clinical sign that different modalities of treatments should be considered (31,32).

Pleurocentesis is the commonest procedure for diagnostic purpose as well as the treatment.

Chest-tube thoracostomy is aimed at the evacuation of pleural fluid, but formation of new fluid as well as reaccumulation is very often (33,34). Pleurodesis is used very often for palliative care of malignant pleural effusions (35). Pleurodesis could be performed with sterile talc, tetracycline, and bleomycin. The aim of the procedure is formation of pleural adhesions and avoidance of new pleural effusions (36,37). Some scoring systems are in use for other purpose, like assessment of non-invasive predictor of EGFR mutation in lung adenocarcinoma. This scoring system is named Computer-Aided Nodule Assessment and Risk Yield (CANARY) (38). Another scoring system is used to predict tissue invasion and patient survival in some lung adenocarcinoma, named Computed Tomography-Based Score Indicative of Lung Cancer Aggression (SILA) (39).

Repetitive pleural effusion remains an unsolved diagnostic and therapeutic challenge. Any help in the process of decision making for diagnostic and treatment purpose is welcome. Chest CT scan scoring system is helpful, and more useful in combination with chest ultrasound.

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