ORIGINAL ARTICLE

ULTRASOUND EXAMINATION OF THE LUNGS IN THE INTENSIVE CARE UNIT IN OBSTETRIC PRACTICE

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ABSTRACT
The aim: Diagnosis of bronchopulmonary pathology in the intensive care unit in patients with obstetric and gynaecological diseases and to implement aspects of the BLUE protocol in an intensive care unit for pregnant women with lung diseases.
Materials and methods: The study involved pregnant women admitted to the intensive care unit at the city centre for reproductive medicine. To study the bronchopulmonary system, an Aloka 3500 ultrasound scanner was used, a chest X-ray was performed, spirometry study of the function of external respiration.
Results: Identified radiological changes in the lungs that were confirmed by ultrasound. Data on changes in external respiration indices showed the presence of respiratory failure by restrictive type and was not accompanied by a change in the gas composition of the blood (SpO_2 and $EtCO_2$).
Conclusions: technique for ultrasound examination of the bronchi-pulmonary system in pregnant women was developed and introduced in the intensive care unit. Ultrasound profiles of lung diseases were identified, which allow determining the intra and extrapulmonary changes in pregnant women in the early stages of pathology.

KEY WORDS: ultrasound examination, pregnant women, lungs, intensive care, bronchopulmonary pathology

INTRODUCTION

Diseases of the bronchopulmonary system occupy priority positions in the structure of the morbidity of pregnant women, during this period the woman's body is most susceptible to the influence of various factors of the external and internal environment.

During pregnancy, physiological changes in the woman's bronchopulmonary system are adaptive. There are such changes as: elevation of the diaphragm by 4 cm; an increase in minute ventilation of the lungs by 30-50%, which progresses with an increase in gestational age; an increase in the minute volume of breathing from 8.4 l / min to 11.1 l / min, associated with an increase in oxygen consumption by 15-20%; dilation of the lumen of the bronchi, which leads to changes in the mechanics of respiration and form a restrictive type of respiratory failure, etc. [1, 2].

A significant effect on the course of bronchopulmonary pathology in pregnant women is exerted by the state of the immune system. During pregnancy, a "physiological tolerance" is formed, which is accompanied by a decrease in the level of T-helpers and natural killers in pregnant women, which leads to a decrease in the woman's body resistance to the altering effects of viral and bacterial agents [2].

Particular attention of doctors is given to HIV-infected women, since this is a special risk group for the development of bronchopulmonary pathology vond complications associated with it. From literature data [3] it is known that, as immunodeficiency progresses in HIV-infected patients, opportunistic infections of various localizations develop (for example, tuberculosis – up to 66.5% in HIV-infected pregnant women). The occurrence of tuberculosis is possible at any stage of HIV infection and this does not depend on the level of CD[4]+lymphocytes. Less common is the development of pneumocystic and cytomegalovirus pneumonia (up to 7.1%). Opportunistic infections, in most cases, cause the death of HIV-infected patients.

Damage to the lower respiratory tract, as well as their severity in patients with HIV infection, depends on the number of CD[4]+lymphocytes in the blood and has a more severe course in pregnant women in the second and third trimester, which is due to the immunological state and physiological changes in the bronchopulmonary system.

Therefore, the above physiological changes in the body of pregnant women raise the question of the need for early diagnosis of extragenital pathology [4].

The inability to use X-ray methods due to its negative effect on the fetus forces researchers to develop alternative and informative diagnostic methods, such as ultrasound. A particularly urgent need for the use of these methods appeared in the intensive care unit in pregnant women with a complicated course of bronchopulmonary pathology [4, 5].

Thus, urgent ultrasound of the lungs in diagnostic accuracy is much superior to radiography performed at the patient's bed, and in sensitivity and specificity it is equal to computed tomography, which ensures the accuracy of the initial diagnosis in 90.5% of cases in patients with acute respiratory failure [6-9].

Table I. Ultrasound and radiological comparison of the clinical situation

Ultrasound and X-ray verification (confirmation)	I group N = 23		II group N = 19	
	n	M±m	n	M±m
Ultrasound and X-ray verification of pneumonia	19	45,2±7,6	18	42±5,6
Ultrasound verification and cases not confirmed radiographically	3	7,1±3,9	1	2,4±1,3
Cases that are not confirmed by ultrasound and radiological diagnostics	1	2,4±1,3	_	_

Table II. External respiration indices

Indicators of the function of external respiration	I group	II group	Control group
PEF, %	44* (37–49)	42* (40–52)	65 (62 -71)
PEF, L/sec	2,76* (2,19–3,20)	2,93* (2,59–3,27)	3,54 (3,16 - 4,20)
FVC, %	68* (63,5–74,5)	72* (68,5–77)	87 (82;92)
FVC, l	2,2*8 (2,05–2,55)	2,44* (2,16–2,69)	3.72 (3,2- 3,8)
R-R, min breathing rate	22 (17 – 25)	20 (18–23)	16 (14 -18)
SpO$_2$ (%)	96 (92 -97)	94 (90–97)	99 (98 – 99)
EtCO$_2$ мм рт. ст.	32 (29-34,2)	30 (30–32,5)	34 (32,2- 35,6)

Note. * - the level of significant difference in the indices of the study groups in comparison with the indices of the control group $p < 0.05$.

An ultrasound examination of the lung pathology is performed within a few minutes and contributes to the early diagnosis of bronchopulmonary diseases, and, therefore, the timely conduct of adequate therapeutic measures, which accelerates the improvement of the condition of patients [10-14].

THE AIM

The aim was to diagnosis of bronchopulmonary pathology in the intensive care unit in patients with obstetric and gynaecological diseases and to implement aspects of the BLUE protocol [15, 16] in an intensive care unit for pregnant women with lung diseases.

MATERIALS AND METHODS

The study involved 42 pregnant women admitted to the intensive care unit at the city centre for reproductive medicine (Kyiv). The main complaints at admission were: shortness of breath (78%), fever (82%), and cough(34%). The average age of the patients was 34.5 ± 1.3 years. All examined patients were pregnant women with different gestational age.

To study the bronchopulmonary system, we used an Aloka 3500 ultrasound scanner using linear (7.5 MHz) and convex sensors (3.5 MHz) in the B-M mode and colour Doppler mapping (CDC) mode.

A chest X-ray was performed in a sitting position in two projections on an X-ray unit PLX-102 Mobile X-ray.

Upon admission to the intensive care unit, all patients underwent a spirometry study of the function of external respiration using a Heaco SP 10 spirometer (China).

The data obtained are systematized and analysed using methods of mathematical statistics using the program Statistica_6, StatSoft by StatSoftInc, USA.

RESULTS

The examined patients are divided into 2 groups depending on the infectious history. The first group included 23 patients with bronchopulmonary pathology and concomitant HIV infection, hepatitis C. The second group consisted of 19 patients with bronchopulmonary pathology in the absence of an infectious history. The control group consisted of 12 women with a physiological course of pregnancy and without concomitant viral and infectious pathologies.

As a result of lung examination, the following data were obtained (Table I):
- the diagnosis of pneumonia was confirmed by signs of ultrasound (ultrasound) and by the results of x-ray examination in 19 (45.2 ± 7.6%) pregnant women;
- cases with positive signs of pneumonia by ultrasound and not confirmed radiologically in 3 women (7.14 ± 3.9%);
- cases with negative signs of ultrasound and not confirmed radiologically – 1 (2.4 ± 1.3%);

The results obtained during radiological studies in the second group showed that:
- cases with positive signs of ultrasound and X-ray examination confirmed the diagnosis of pneumonia in 18 pregnant women (42 ± 7.6%);
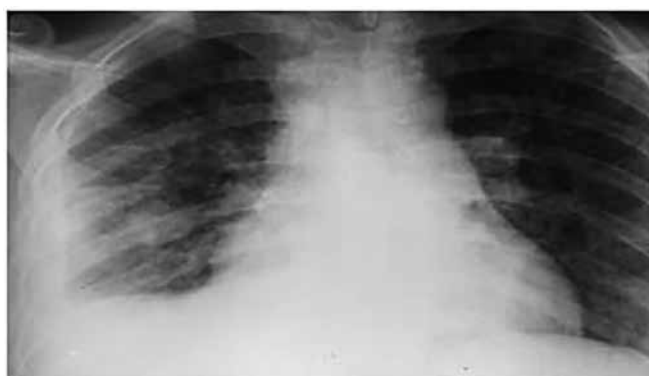
Fig. 1. Ultrasound of patient T.

Fig. 2. Radiographic data of patient T.

Fig. 3. Patient C.

- cases with positive signs of ultrasound and not confirmed by radiological findings were found in 1 pregnant patient (2.4 ± 1.3%).

X-ray studies were not performed in patients of the control group, because according to ultrasound, there were no signs of lung disease.

Considering the results of an X-ray examination, exudative pleurisy was most verified in patients of the first group – 21 cases (50 ± 7.7%); lung atelectasis – 6 (12.4 ± 1.3%); tuberculosis – 5 (11.9 ± 4.9%) cases. In patients of the second group, interstitial lung lesion was detected more often – 16 (84.3 ± 7.3).

Pulse oximetry was monitored for all patients and external respiration indices were evaluated (Table II). The study of the function of external respiration was carried out using a spirometer SP 10 "Naso medical technology". Using this device, we determined the forced vital capacity of the lungs (FVC) (FVC), the volume of forced expiration during the first second (FEV1) (FEV1), the peak expiratory flow rate (PEF) (PSV), the peripheral blood saturation SpO_2, the carbon dioxide content at the end expiration ($EtCO_2$). In addition, the ratio of the determined indicator to the proper indicator was evaluated.

The analysis of measurements of indicators of the function of external respiration indicates impaired ventilation of the lungs by restrictive type. There was a significant decrease in PEF compared to the control group 1.5 times in patients of group I and 1.54 times in patients of group II, respectively ($p < 0.05$). There was no significant difference in PEF between group I and group II. Patients in the study groups showed a statistically significant decrease in FVC values by 1.2-fold ($p < 0.05$) compared to the control group. These changes in indicators of external respiration indicate the presence of respiratory failure by restrictive type, which were not accompanied by changes in blood gas composition (SpO_2 and $EtCO_2$).

All patients underwent ultrasound examination of the lungs according to standard methods.

According to the ultrasound concept of the bronchopulmonary system, we examined patients with the following respiratory failure profiles: normal lung profile (23%); profile with interstitial syndrome 17%; profile with pleural effusion (60%).

Figure 1 shows the ultrasound of patient T. during pregnancy for 26 weeks with a diagnosis of admission: Tuberculosis of the respiratory system. Progressive bilateral fibrous-cavernous pulmonary tuberculosis, exudative bilateral pleurisy, respiratory failure (DN) III. Meningoencephalitis. Hyperthermic syndrome. Chronic viral hepatitis C. HIV infection.

Pregnancy 26 weeks. Diagnosis: respiratory tuberculosis. Progressive bilateral fibro-cavernous pulmonary tuberculosis, exudative bilateral pleurisy, DN III. Meningoencephalitis. Hyperthermic syndrome. Chronic viral hepatitis C. HIV infection.

Echography symptoms are represented by the presence of fluid in the pleural cavities. Against the background of exudate, single septa were found, represented by hyperechoic strands, which had an uneven thickness (4-18 mm) and sagged into the lumen of the pleural cavity.

The ultrasound data of this patient were compared with radiographic data, where cavernous lesions in the lower lobe of the right lung were verified (Fig. 2).

Pregnancy 26 weeks. The diagnosis is respiratory tuberculosis. Progressive bilateral fibrous-cavernous pulmonary tuberculosis, exudative bilateral pleurisy, DN III. Meningoencephalitis. Hyperthermic syndrome. Chronic viral hepatitis C. HIV infection.
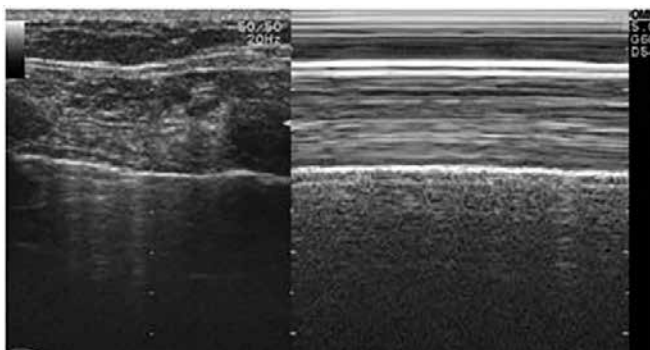
Fig. 4. Patient T.

Fig. 5. Patient B.

The radiograph (Fig. 2) shows the cavity of the cavity with an annular shadow, which has, in most cases, spherical or ellipsoidal shapes. The wall thickness of the cavity is due to the fibrous capsule and perifocal inflammation.

Ultrasound examination of the lungs allows you to diagnose the minimum amount of exudate and its nature in the pleural cavities. The diagnostic value of the method is relevant in conditions where the use of an X-ray examination of the lungs is contraindicated or impossible.

Figure 3 presents the data from a study of patient C. with a pregnancy of 29 weeks and with a diagnosis of bilateral tuberculous exudative pleurisy.

The fluid in the right pleural sinus is diagnosed at the level of 2 ribs, which is an indication for pleural puncture.

The echography symptoms of pleurisy of tuberculous etiology were characterized by the following: on the background of exudate, single septa were found that were hyperechoic, had an uneven thickness (4-19 mm), and sagged into the pleural cavity. The overlays on the pleura were visualized throughout the entire visible area, or locally and were characterized by clear uneven contours, average echogenicity with a variable thickness of up to 21 mm. Their structure was characterized by homogeneity (Fig. 3).

Pregnancy 34 weeks. Bilateral exudative pleurisy.

On the background of an echo-negative fluid, reticular fibrous hyperechoic strands are visualized, the size and location of which was different for each patient and is not related to the course and duration of the disease (Fig. 3, 4).

Pregnancy 34 weeks. Exudative specific bilateral pleurisy. A valuable diagnostic aspect of ultrasound examination of the lungs is the ability to diagnose the presence and absence of a profile of pneumothorax (Fig. 5).

Pregnancy 35 weeks. Suspected pneumothorax. Bilateral lower lobar pneumonia.

On the echogram, the pleura line is visualized in the form of a hyperechoic line and the sign of a "sea breeze" in the M-mode of scanning.

DISCUSSION

The use of the ultrasound method for diagnosing pulmonary pathology in pregnant women in the intensive care unit in parallel with the X-ray method also made it possible to identify changes in the parameters of external respiration. All radiological changes in the lungs of pregnant women were confirmed by ultrasound data [5, 6].

The revealed changes in the lungs were characterized by the presence of more than 3 B lines in the corresponding lobe of the lung, which is a characteristic of the interstitial – alveolar syndrome in pneumonia. The presence of subpleural consolidations correlated with the severity of pneumonia and the presence of ventilation failure [8].

The detection of fluid in the pleural cavities had high sensitivity and specificity with a minimum volume of fluid from 15 ml, while X-ray verification of the presence of fluid in the pleural cavities was possible only with an amount of fluid with a minimum volume of 112 ml. Therefore, this ultrasound research method is the most sensitive.

In addition, it was found that ultrasound can determine intrapulmonary and extrapulmonary changes in the early stages of pathology, which is important when using this diagnostic method in pregnant women, as a gentler, fast and at the same time informative method.

Such diagnostics can be widely used in pediatric practice as a good alternative to other methods of examination.

CONCLUSIONS

1. A technique for ultrasound examination of broncho-pulmonary pathology in pregnant women has been developed and implemented.
2. Ultrasound criteria for lung diseases of pregnant women (pneumonia, pleurisy) were identified in the intensive care unit.
3. This methodology and criteria for lung diseases make it possible in the early stages of pathology to determine the intra and extrapulmonary changes in the broncho-pulmonary system in pregnant women.
4. The ultrasound picture of lung diseases is due to general clinical and ultrasonic features of the reflection of ultrasonic waves from altered structures.
5. Ultrasonic semiotics of pleurisy is characterized by the presence of echo-negative contents in the pleural cavities.

6. In patients with lung diseases, there was a restrictive type of respiratory failure without a change in the gas composition of the blood.

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The Authors declare no conflict of interest.

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D – Writing the article, **E** – Critical review, **F** – Final approval of the article