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Corresponding author / Адреса для кореспонденції
Pylypets Olena Yuriyivna / Пилипець Олена Юріївна
SI «Institute of Neurology, Psychiatry and Narcology of the NAMS of Ukraine» / ДУ «Інститут неврології, психіатрії та наркології НАМН України»
Ukraine, 61000, Kharkiv, 46 Akademika Pavlova str. / Адреса: Україна, 61000, м. Харків, вул. Академіка Павлова 46
Tel.: +380503437299 / Тел.: +380503437299
E-mail: pelya_71@ukr.net

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Khanaliyeva N. F.

SPECTRUM OF CHEST IMAGING DATA IN CHILDREN WITH INFLAMMATORY LUNG DISEASES

Scientific Research Institute of Pediatrics named after K. Faradzheva (Baku, Azerbaijan)
statya2021@yandex.ru

200 children aged 0 to 1 years who were admitted to the K.Y. Faradzheva Research Institute of Pediatrics in the period 2019-2021 were examined. All examined children were divided into 4 groups: 1) newborns, 2) infants, 3) children older than 1 year, 4) children without pathology of the respiratory system. In the work, Shimadzu Flexavision,Toshiba portable Xray Unit and Medison Sonoacer 7,Siemens Acuson P300 devices were used for X-ray examinations, Toshiba portable Xray Unit for children in serious condition, and ultrasound device Medison Sonoacer 7 and portable ultrasound device Siemens Acuson P300.

In the structure of the focus with pronounced inflammatory infiltration in pneumonia, using ultrasound of the patient's lungs, air bronchograms with uneven lower edges and upper edges of the focus adjacent to the pleural line are visualized, which, in turn, are practically absent and are not detected during ultrasound examinations in patients with total lung atelectasis, which, against this background, has a homogeneous isoechogenic structure. In addition to visualization of certain, real-life structures of lung tissue during ultrasound, it is possible to register additional two diagnostically important patterns of acoustic artifacts, one of which is hyperechoic multiple lines or so-called A-lines located at regular intervals and horizontally directed, represents a deep reflection of the wave from the line of the pulmonary pleura, is mainly a sign of a normal amount of air in the alveoli and is more often fixed in the examined healthy children.

Ultrasound is a sensitive method for detecting pneumonia and their characteristic signs or artifacts in newborn children.

Key words: *pneumonia, newborns, ultrasound, artifacts.*

The connection of the publication with planned research works.

This work is a fragment of a dissertation for the degree of Doctor of Philosophy in medicine.

Introduction.

Despite the rather frequent attention of specialists to the problem of using the ultrasound method to study lung tissues in the diagnosis and assessment of the severity of pneumonia, the results of scientific studies and their comparative analysis indicate [1, 2, 3] that there are controversial issues that require accuracy in the interpretation of registered ultrasound changes. For example, an assessment of the airless area of the lung tissue is done to clarify the semiotics of airless fragments of the lung tissue (inflammatory infiltration, atelectasis), depending on the presence of pneumonia of various morphological types. In the course of the research, the results of radiography and ultrasound techniques for assessing the state of the chest organs are studied in detail, more precisely, the ultrasound picture and anatomy of pathological changes, the radiation semiotics of these changes, as well as their localization and extent are determined [4, 5, 6, 7]. These studies present data on the frequency of detection of diagnostically important hypo- and hyperechoic structures, inflammatory infiltrate, artifacts, A-line, B-line and a comparative analysis of the obtained indicators with the results of studies by foreign authors [8]. The identified interstitial changes, the presence of which is indicated by the fact of visualization of multiple B-lines, include pulmonary edema, effusion into the pleural cavity, pneumonia, and respiratory distress syndrome. At the same time, specialists identify and convincingly pres-

ent the high diagnostic capabilities of timely ultrasound scanning of the lungs, also to exclude these pathological conditions [9]. B-lines, or "comet tail" artifacts, the number of which increases in pulmonary pathology (the more severe the course of the pathological process and the more pronounced changes in lung tissues, the more such artifacts) are easily detectable hyperechoic linear formations extending from pleura, against the background of preservation of echogenicity, and are indicated as one of the main signs of interstitial changes in the lungs, characterized by the presence of appropriate interstitial infiltration. According to the data we obtained in the article, which are consistent with the opinion of foreign authors, the visualization of multiple B-lines in certain scanning areas, which is due to the accumulation of extravascular fluid in the interlobular septa and their subsequent thickening, indicates the presence of interstitial disorders [10, 11, 12]. So, for example, with pulmonary edema, a uniform, often symmetrical on both sides, arrangement of multiple B-lines over the entire surface of the lung fields is observed. The formation of such artifacts in the form of vertically directed ultrasonic reverberation signals can be represented as follows: an ultrasonic beam partially penetrates the parenchyma of the lungs, with a decrease in its airiness due to the accumulation of fluid in the alveoli, in the area of interlobular septa, due to a decrease in the difference in complex acoustic parameters or in indicators environmental resistance between areas of pathologically altered lung parenchyma and surrounding tissues [13].

The aim of the study.

To identify the most important aspects of lung imaging with an emphasis on ultrasound data for optimal diagnosis of pneumonia in children.

Object and research methods.

In the course of these studies, some diagnostically important echographic signs and symptoms with maximum accuracy, in particular, in newborns, have been identified. These, in particular, include: pleural effusion; a symptom of lung sliding, detected in real time with simultaneous displacement of the visceral pleura relative to the parietal one with respiratory movements; signs of pneumothorax; A-lines, lines repeating at regular intervals, traced below and parallel to the pleural line and characterized by ultrasonic features similar to it, as well as "comet tails". According to some foreign authors, the disappearance of A-lines and the appearance of "comet tails" are observed at some pressure that occurs in the pulmonary artery; etc. [14, 15, 16]. To diagnose lung diseases in the examined children, we used a basic device with a probe characterized by a known frequency and size, as well as a high spatial resolution. This allows, with a perpendicular arrangement, to visualize both the upper and lower lung fields in a premature newborn child at the same time. To standardize the methodology when conducting research, for example, in the position of the patient on the back, on the side or on the stomach, it is necessary to use a single protocol for performing lung ultrasound, verified for a particular medical institution. Thus, in intensive care units, where timely and accurate diagnosis is very important, foreign authors suggest scanning each lung at four standard points (method, D.A. Lichtenstein) [17]. Based on the results of scientific studies based on the principles of evidence-based medicine and determining the level of evidence for each ultrasound indicator, a detailed assessment of the possibilities of lung ultrasound in dynamic monitoring and in assessing the effectiveness of ongoing therapeutic and preventive measures in children with pneumonia and other pathological disorders in the lungs was made. For sufficiently effective ultrasound imaging of pneumonia, atelectasis, that is, airless lung lesions, pneumothorax, it is necessary to examine children in a vertical position of the body, in addition to X-ray diagnostics, which is carried out in the position of the child lying down. At the same time, it is very important, due to the insufficient reliability of low-frequency ones [18], to use high-frequency sensors (7.5 MHz), in particular, to detect a sign of pleura slip and "comet tail" (point artifacts). Thus, for the first time, ultrasound signs of the main pathological conditions of the lungs, which are often observed in newborn children with pneumonia, were determined in the work. In the course of these studies, the effectiveness of the ultrasound technique for visualizing pathological changes was revealed and these data were compared with the results of radiography for timely accurate diagnosis and determination of the severity of pulmonary pathology in newborns. In the course of these studies, the results of dynamic observation using the ultrasound method for assessing the state of the chest of newborns and children under one year old were analyzed. We examined 200 children aged 0 to 1 year who were admitted to the Research Institute of Pediatrics. K.Yu. Farajev in the period 2019-2021. All examined children: 1) newborns, 2) infants, 3) children over 1 year old, 4) children without pathology of the respiratory system. For children older than one year, ultrasound was performed in a vertical and horizontal position, for children under one year old – only in the prone position. The anterior sections of the lungs and pleura were examined in the child's sitting position with the shoulders as straight as possible, the lateral sections – with the arm raised up, the posterior sections – with the back slightly bent, and when examining the posterior sections of the upper lobes – with additional alternate abduction of the arm obliquely upwards in the opposite direction. Scanning was carried out in the longitudinal and transverse planes, with a smooth swaying of the sensor when moving it along the intercostal space. When visualizing a section of airless lung tissue, it was measured in two mutually perpendicular planes, its localization was determined by lobes and segments, contours, echogenicity, and echostructure were evaluated **(table 1).**

Shimadzu Flexavision, Toshiba portable Xray Unit and Medison Sonoacer 7, Siemens Acuson P300 devices were used for X-ray examinations, Toshiba portable Xray Unit for children in serious condition, and Medison Sonoacer 7 ultrasound device and Siemens Acuson P300 portable ultrasound device. The studies were carried out with the written consent of the patients in compliance with the norms of biomedical ethics set forth in the Declaration of Helsinki "Ethical Principles for Medical Research Involving Humans", developed by the World Medical Association, "Universal Declaration on Bioethics and Human Rights (UNESCO)". Statistical data processing was performed using the application software package "Statistica 8.0". Quantitative signs with a normal distribution were described by mean and standard deviations (M±s). When comparing more than two independent samples in the presence of a normal distribution, one-way analysis of variance ANOVA was used, in the presence of an abnor-

Table 1 – Characteristics of the groups of examined children

Group	full-term			premature			Total		
	Main group			Control group					
	newborn	infancy	Total	newborn	infancy	Total	newborn	infancy	Total
	Abs.	Abs.	Abs.	Abs.	Abs.	Abs.	Abs.	Abs.	Abs.
Control group	29	20	49	11	5	16	40	25	65
Main group	59	29	88	41	6	47	100	35	135
Total	88	49	137	52	11	63	140	60	200

mal distribution of features, nonparametric analysis of variance Kruskal-Wallis was used. The Pearson chi-square test also was used for qualitative data between groups. Differences were considered statistically significant at a significance level of P<0.05.

Research results and their discussion.

Ultrasound findings, which included pleural line irregularities and decreased lung glide, were statistically significant (p<0.0001). Diagnostically and prognostically important is the appearance of artifacts such as a "torn" line, which outlines the area of consolidation and thus delimits it from a healthy aerated region of the lung, while the superficial border of subpleural consolidation is most often represented by a flat line of the pleura of the hyperechoic type, and its relatively deep lower the border is represented by a jagged line. Normal sliding of the visceral pleura in association with respiratory movements, a factor that is noted as a sign of "seashore", is detected when examining and visualizing a normal intact lung. Due to the reflection of ultrasonic rays from the air in the bronchi and the formation, at the same time, of linear hyperechoic signals in the form of a hypoechoic area with a heterogeneous structure, a symptom is detected, presented as an air echobronchogram. Quantitative and qualitative indicators of the elements of an air echobronchogram, with good severity, can serve as one of the main criteria and prognostically favorable signs indicating the rate of resorption of the inflammatory infiltrate and the reverse development of the pathological process, in this case pneumonia, and depend on the severity of its course. In a comparative analysis of the data obtained at the initial stage, this artifact was detected in 17 children of the main group (12.7%), while only unilateral manifestations of the trait were visualized, against the background of its complete absence in practically healthy children of the control group (p<0.0001). After the ultrasound examination, in the examined patients of the main group, multiple artifacts of the "comet tail" were recorded at the site of pneumonia, while maintaining which, and against the background of thickening of the pleura, in a satisfactory condition of the patient, ultrasound of the chest and lung parenchyma was performed again. It should be noted that linear hyperechoic signals were detected in patients with pulmonary pathology. On echograms in children not burdened by the studied pathological processes, this phenomenon was absent **(table 2).**

Table 2 – Main ultrasound signs of pulmonary pathology in children

US Signs	Affected area	Control group		Main group	
Dynamic. air bronchogram	Not detected	65	100,0%	117	87,3%
	1 sided	0	0,0%	17	12,7%
	2-sided	0	0,0%	0	0,0%
B-line	Not detected	64	98,5%	27	20,1%
	1 sided	1	1,5%	41	30,6%
	2-sided	0	0,0%	66	49,3%
fluid	Not detected	65	100,0%	115	85,8%
	1 sided	0	0,0%	19	14,2%
	2-sided	0	0,0%	0	0,0%
Pleural line irregularities	Not detected	64	98,5%	54	40,3%
	1 sided	1	1,5%	29	21,6%
	2-sided	0	0,0%	51	38,1%
A-lines	Not detected	0	0,0%	66	49,3%
	1 sided	1	1,5%	43	32,1%
	2-sided	64	98,5%	25	18,7%
Lung sliding	Not detected	65	100,0%	101	75,4%
	1 sided	0	0,0%	32	23,9%
	2-sided	0	0,0%	1	0,7%
Dynamic.air bronchogram	Chisquare	21,687			
	df	2			
	Sig.	0,000			
B-line	Chisquare	108,226			
	df	2			
	Sig.	0,000			
Fluid	Chisquare	10,189			
	df	1			
	Sig.	0,001			
Pleural line irregularities	Chisquare	61,443			
	df	2			
	Sig.	0,000			
A-line	Chisquare	112,820			
	df	2			
	Sig.	0,000			
Lung sliding	Chisquare	19,190			
	df	2			

In the course of ultrasound studies, along with the visualization of the phenomenon of "air bronchography" and compaction of the lung tissue, the ultrasound method allowed us to identify artifacts such as the "comet tail" and small and large foci of destruction of somewhat increased echogenicity with inclusions with a fuzzy contour in the center. That is, in an airless area in patients with pneumonia, an irregularly shaped zone of reduced echogenicity is often recorded. According to the presented tabular data, with pneumonia, a frequent, compared with the control group (1.5% and 0.0% – 1-sided and 2-sided, respectively), presence of the B-line (30.6% and 49. 3%, 1-sided and 2-sided, respectively in the main group) with involvement of the intercostal spaces in the process. Along with this, statistically significant data were obtained when studying the frequency of subpleural indurations (p<0.0001).

Pneumonia in the children examined by us almost always proceeded with the appearance of pleural effusion of different volumes. The presence of excess fluid is more often observed against the background of pulmonary pathology and unilaterally, that is, in the main group – 14.2%, with the complete absence of a symptom in practically healthy children who made up the control group, which was a significant and statistically significant result (p=0.000). A small amount of pathological fluid can be visualized as a slit-like space between the pleural sheets in the area close to the zone of pneumonia. As excess fluid accumulates, that is, an increase in effusion, it spreads and begins to manifest itself in other parts of the pleural cavity. Thus, when studying structural changes in the lungs, against the background of pathological changes and disorders, ultrasound studies revealed the filling of the alveoli with exudate and a decrease in their airiness, and, as a result, areas of lung tissue compaction and the so-called areas of consolidation were recorded. Simultaneously with this fact, in the studied diseases of the respiratory system, reticulonodular opacities and a statistically significant increase in the air bronchogram artifact prevailed. Ultrasound, based on reliable indicators, showed subpleural consolidation, air bronchogram and B-lines as the most common signs of pathology of the bronchopulmonary system. In the course of these studies, some distinctive features of ultrasound scanning and X-ray studies were identified in assessing the state of lung tissue in children with pneumonia, pneumothorax and practically healthy individuals of the same age, not burdened by pulmonary pathology. So, in the presence of inflammatory changes, intermittent pleural lines were observed: unilateral in 21.6% and bilateral in 38.1% of cases, which was significantly higher than in the control group, where only one child had this phenomenon, which amounted to only 1.5% of the total number of children in the control group. In addition to visualization of certain real-life structures of the lung tissue during ultrasound, it is possible to register two additional diagnostically important patterns of acoustic artifacts, one of which is hyperechoic multiple lines located at regular intervals and horizontally directed, or the so-called A-lines, which is a deep reflection of the wave from the line pulmonary pleura is mainly a sign of a normal amount of air in the alveoli and is more often recorded in examined healthy children.

Conclusions.

In accordance with the results obtained, it is possible to testify to the high diagnostic efficiency and accuracy of ultrasound, compared with radiography in the diagnosis of inflammatory lung diseases in newborn children. The presence of the B-line was more noticeable in infants with pneumonia than in the control group. A prognostic sign of inflammatory diseases of lung tissue is the presence of subpleural consolidation with sonographic air bronchograms, detected by ultrasound. Ultrasound also allows you to accurately and timely diagnose the presence, nature and volume of pleural effusion and, against this background, distinguish pathologies of the respiratory system. Thus, ultrasound is a sensitive method for detecting pneumonia and their characteristic signs or artifacts. In the middle lobe, an inflammatory infiltrate is determined by a section of airless lung tissue with elements of an air echobronchogram, which was a reflection in the bronchi of rays from air masses and due to linear hyperechoic signals, with a relatively severe degree of the course of the pathology under study, represented by a hypoechoic area with structural disorders. We have identified it in children with pulmonary pathology, more often in the form of interrupted lines or short segments, less often branching and having sufficient length. Ultrasound of the mediastinum makes it possible to determine the depth of pathological changes in the condition of the lungs in various diseases in newborns, both full-term and premature babies.

Prospects for further research.

It is planned to further study the possibilities of optimal diagnosis of pneumonia in children.

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СПЕКТР ДАНИХ ВІЗУАЛІЗАЦІЇ ГРУДНОЇ КЛІТКИ У ДІТЕЙ ІЗ ЗАПАЛЬНИМИ ЗАХВОРЮВАННЯМИ ЛЕГЕНЬ

Ханалієва Н. Ф.

Резюме. Були обстежені 200 дітей віком від 0 до 1-го року, що поступили у НДІ Педіатрії ім. К.Ю. Фараджева у період 2019-2021 рр. Всі обстежувані діти були поділені на 4 групи: 1) новонароджені, 2) діти грудного віку, 3) діти старше 1 року, 4) діти без патології дихальної системи. Дітям старше одного року УЗД проводили у вертикальному та горизонтальному положенні, дітям молодше одного року – лише в положенні лежачи. Передні відділи легень та плеври досліджувалися у положенні дитини сидячи з максимально прямими плечами, бокові відділи – з піднятою уверх рукою, задні відділи – з дещо зігнутою спиною, а при огляді задніх верхніх часток – з додатковим почерговим відведенням піднімали руку під нахилом уверх в протилежному напрямку. У роботі для рентгенологічного дослідження використовувалися апарати Shimadzu Flexavision, Toshiba portable Xray Unit та Medison Sonoacer 7, Siemens Acuson P300, для дітей у тяжкому стані Toshiba portable Xray Unit, а УЗД апаратом Medison Sonoacer 7 та портативним УЗД Siemens Acuson P300 апаратом.

У структурі вогнища з вираженою запальною інфільтрацією при пневмонії з використанням УЗД легень пацієнта візуалізуються повітряні бронхограми з нерівними нижніми краями та верхніми краями вогнища, що прилягають до плевральної лінії, які в свою чергу практично відсутні та не виявляються при ультразвукових дослідженнях у пацієнтів з тотальним ателектазом легені, що володіє, на цьому фоні, однорідною ізоехогенною структурою. Окрім візуалізації певних, реально існуючих структур легеневої тканини при проведенні УЗД можлива реєстрація додаткових двох діагностично важливих патерна акустичних артефактів, одним з яких є розташовані через рівні проміжки та горизонтально направлені гіперехогенні множинні лінії чи так звані А-лінії, являють собою глибокі відбиття хвилі від лінії легеневої плеври, є головним чином ознакою нормальної кількості повітря у альвеолах та частіше фіксується у обстежуваних здорових дітей.

УЗД є чутливим методом для виявлення пневмоній та характерних для них ознак чи артефактів у новонароджених дітей.

Ключові слова: пневмонія, новонароджені діти, ультразвукове дослідження, артефакти.

SPECTRUM OF CHEST IMAGING DATA IN CHILDREN WITH INFLAMMATORY LUNG DISEASES

Khanaliyeva N. F.

Abstract. 200 children aged 0 to 1 years who were admitted to the K.Y. Faradzhev Research Institute of Pediatrics in the period 2019-2021 were examined. All examined children were divided into 4 groups: 1) newborns, 2) infants, 3) children older than 1 year, 4) children without pathology of the respiratory system. For children older than one year, ultrasound was performed in a vertical and horizontal position, for children younger than one year – only in the supine position. The anterior sections of the lungs and pleura were examined in the child's sitting position with the shoulders as straight as possible, the lateral sections – with the arm raised up, the posterior sections – with a slightly bent back, and when examining the posterior sections of the upper lobes – with an additional alternate lead, raise the arm obliquely upwards in the opposite direction. In the work, Shimadzu Flexavision,Toshiba portable Xray Unit and Medison Sonoacer 7,Siemens Acuson P300 devices were used for X-ray examinations, Toshiba portable Xray Unit for children in serious condition, and ultrasound device Medison Sonoacer 7 and portable ultrasound device Siemens Acuson P300. In the structure of the focus with pronounced inflammatory infiltration in pneumonia, using ultrasound of the patient's lungs, air bronchograms with uneven lower edges and upper edges of the focus adjacent to the pleural line are visualized, which, in turn, are practically absent and are not detected during ultrasound examinations in patients with total lung atelectasis, which, against this background, has a homogeneous isoechogenic structure. In addition to visualizing certain, real-life structures of lung tissue during ultrasound, it is possible to register additional two diagnostically important patterns of acoustic artifacts, one of which is hyperechoic multiple lines or so-called A-lines located at regular intervals and horizontally directed, represents a deep reflection of the wave from the line of the pulmonary pleura, is mainly a sign of a normal amount of air in the alveoli and is more often fixed in the examined healthy children. Ultrasound is a sensitive method for detecting pneumonia and their characteristic signs or artifacts in newborn children.

Key words: pneumonia, newborn babies, ultrasound examination, artifacts.

ORCID and contributionship:
Khanaliyeva N. F.: – [ABCDEF]

Corresponding author
Khanaliyeva Nargiz Fizuli
Scientific Research İnstitute of Pediatrics named after K. Y. Farajova
Azerbaijan, *AZ1065,* Baku, 15B Basti Bagirova str.
Tel.: +994557621780
E-mail: statya2021@yandex.ru

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