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Integrated Radiation Diagnostics of Pulmonary Complications of Pneumonia in Children

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Annotation--- *An important role in the diagnosis of pneumonia and their complications is given to the integrated use of radiation research techniques. The possibilities of using new methods of radiation diagnostics (digital radiography, ultrasound, multispiral computed tomography and magnetic resonance imaging) have increased. Each method has characteristic diagnostic capabilities and indications for its use. The possibility of early and differential diagnosis of pneumonia complications using the above types of studies is of great importance for the timely conduct of adequate therapy, which prevents the progression and development of complications of the disease. The cited semiotics of complicated pneumonia using new types of imaging in radiation diagnostics is presented incompletely. Currently, in the early and differential diagnosis of pneumonia complications, there is no experience with complex radiation diagnostic methods of examination, the algorithm for their application has not been clarified. In a few works, there is only data on their capabilities in the diagnosis of pneumonia complications, but there is no information on the integrated use with effectiveness. In modern medicine, the study of pathological processes, the assessment of the morphological and functional state of tissues and organs, the diagnosis and differential diagnosis, treatment control are unthinkable without X-ray, ultrasound and magnetic resonance imaging studies. These studies are accessible, informative and, importantly, non-traumatic.*

Keywords--- *Children, Pneumonia, Pneumonia Complications, Ultrasound Diagnostics, Lungs, Pleura.*

I. RELEVANCE OF THE STUDY

According to the World Health Organization [1], pneumonia and their complications is one of the leading causes of death in young children, which significantly affects the demographic situation in certain regions of the globe. The incidence and quality of life in a given country are significantly affected by the incidence of acute pneumonia and is the cause of mortality mainly in children under 5 years of age [2, 3, 4].

The outcomes of the treatment of lung diseases largely depend on their early diagnosis. In this regard, there is no doubt the relevance of the diagnosis of non-specific inflammatory diseases. Modern methods of clinical examination using x-ray, bronchoscopic studies do not allow to fully ensure high-quality and timely diagnosis [5, 6]. The frequency of diagnostic errors in various pathological processes in the lungs varies from 19% to 89.5% [7].

The most important diagnostic test is chest x-ray. Diagnosis of pneumonia almost always involves the detection of local changes in the lungs in combination with the corresponding symptoms of a lower respiratory tract infection.

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The value of radiography is not only in the fact of visualization of pneumonic infiltration, but also in assessing the dynamics of the pathological process and the fullness of recovery[8, 9, 10]. Changes in the roentgenogram (the prevalence of infiltration, the presence or absence of pleural effusion, cavity destruction) correspond to the severity of the disease and allow you to adequately choose antibiotic therapy [11, 12, 13].

The rapid development of technologies, including medical equipment, leads not only to the emergence of new methods of radiation diagnostics, but also contributes to their continuous improvement [14, 15]. So, from the 70-80s of the XX century. began to apply ultrasound, computed tomography and magnetic resonance imaging, and in recent years developed their advanced varieties. The use of these methods should be differentiated, shown, really necessary for the correct diagnosis and subsequent optimal treatment [16, 17].

Duration of stay of patients in medical institutions do not tend to decrease. Complicated cases of the disease are increasingly common: pleurisy, purulent-destructive processes. Cases of severe pneumonia, often ending in death, have become more frequent [18, 19, 20]

The use of new medical imaging technologies, including complex ultrasound, magnetic resonance imaging and digital x-ray studies, occupy a leading position in the diagnosis of pneumonia and their complications in children is one of the promising areas in pediatrics.

Purpose of the Study

Improving the diagnosis of pneumonia and their complications in children by using modern methods of medical imaging.

II. MATERIALS AND RESEARCH METHODS

The work is based on the results of a comprehensive standard examination of 103 children with pneumonia and 31 with complications of pneumonia from the age of 1 to 18 years who were examined and treated at the clinic of the Tashkent Pediatric Medical Institute. Clinical and laboratory, complex ultrasound, digital radiological, magnetic resonance imaging (MRI) and multispiral computed tomographic (MSCT) methods were used. The examination was carried out using ultrasonic devices «SONOSCAPE SSI 5000» and «APLIO 500» with sector and linear sensors with a frequency from 3.5 MHz to 7.5 MHz, the choice of scanning frequency depended on the age of the child, the size and depth of the pathological focus. Digital x-ray studies were carried out using the SAXO 30 X-ray diagnostic apparatus. Multispiral computed tomography was performed on a 64 - slice multispiral computed tomography company SIEMENS, SOMATOM PERSPECTIVE. MRI studies were performed on a 1.5 T closed-type MRI device from BRIVO 355 W GE with "breath holding" technology.

III. THE RESULTS OF THE STUDY

Of the 134 children examined, 103 children were diagnosed with pneumonia of various forms and 31 children also had pneumonia complications, such as bacterial destruction of the lungs in 18, exudative pleurisy in 6, lung abscess in 6 children and empyema in 1 patient. Echogenic, branching, intermittent strips that are air-filled bronchi, as well as tubular anechogenic structures - vessels or fluid-filled bronchi and less often thin linear echogenic strips of connective tissue intersegmental septa, were visualized in airless pneumatic foci. The echogenic strip of pleura

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above the airless area (pneumatic focus) looked much thinner than over the air lung.

In 49 children with focal pneumonia, airless lung areas of round and irregular shape were visualized. They had a slightly reduced or medium echogenicity. Inside them, echogenic discontinuous, radially extending strips were visualized — air-filled bronchi, anechogenic tubular structures — vessels and fluid-filled bronchi, thin echogenic strips — intersegmental septa. In 18 children, an amplification effect was noted behind the pleural strip, which had a "rough" appearance in this place. The airless areas at the onset of the disease had an irregular or close to round shape and sizes greater than 5 mm. In 2 children, a mosaic pattern was observed with alternation of airless and air-filled sections of the lung. The listed changes in the lungs were accompanied by a slight accumulation of fluid in the pleural cavity, which was visualized as a separation of the pleural sheets. Increased echogenicity or increased reverberation were specific signs of focal pneumonia. The occurrence of this phenomenon was associated with an increase in the lymphatic flow concomitant with all these diseases, and the passage of the ultrasound beam through the expanded superficial lymphatic network, which combines the lymphatic system of the visceral pleura and the cortical layer of the lung, as well as with an increase in blood supply to subpleurally located blood vessels.

On radiographs in such patients, foci of dimming of various shapes and sizes and increased pulmonary pattern were noted. As pneumonia resolved, multiple hyperechoic air inclusions appeared in the outbreak. The outlines of the focus became fuzzy and uneven, and after 12-14 days, hyperechoic inclusions were visualized at the site of these sites. In 2 children with polysegmental pneumonia, the airless area had a pyramidal shape, facing the pleura. The x-ray picture was characterized by a decrease in the transparency of the affected area of the lung tissue of medium intensity, a homogeneous structure with fuzzy contours.

In 3 patients, X-ray negative pneumonia was revealed, as well as a deep location of the focus of infiltration, which were not detected radiologically, but MSCT was able to identify inflammatory foci.

With a complicated course of pneumonia, in children with bacterial destruction of the lungs with dynamic ultrasound, airless sections increased in size, several smaller ones merged into larger ones. At the same time, small areas of somewhat increased echogenicity appeared in the airless part of the lung, in the center of which then anechogenic inclusions with a fuzzy contour appeared, which were surrounded by an echopositive rim, i.e. foci of destruction. With adequate therapy, they disappeared.

In infants, a "motley" picture was often noted with an alternation of small airless and airy sections of the lung. Apparently, this was due to the presence of small atelectasis. The pleural effusion associated with acute pneumonia, according to our observations, was localized in small amounts in the sinuses, its large accumulations could compress the lower parts of the lungs, but locally it did not protrude towards the lung and did not have an uneven edge on the border with the lung. The x-ray picture was presented in the form of a dimming site resembling polysegmental pneumonia and destruction was not determined.

With a lung abscess, ultrasound imaging was possible in 100% of cases. Using ultrasound, we visually observed the echographic dynamics of the lung abscess and identified the echographic stages of the formation of the lung abscess. At the first stage of abscess formation, the destruction of the pulmonary parenchyma was observed, which was characterized by a round or irregular shape of the lesion, the absence of its clear boundaries and capsule,

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anechogenic structure, which was associated with the process of the onset of melting of the lung tissue. At the second stage of formation, the non-draining lung abscess was echographically visualized in the form of an anechogenic formation of a round shape with clear even contours with hyperechoic suspension in the lumen (pus). The capsule along the periphery of the abscess had clear boundaries, a hyperechoic structure, a thickness of 1.0-1.5 mm. Ultrasonic visualization of the abscesses draining in the bronchus during the third stage of formation became much more difficult due to the appearance of air with a screening effect in it. The stage of resolving the abscess was characterized by complete emptying of the focus from pus and obliteration of the cavity with subsequent resorption. During dynamic ultrasound examination in the abscess cavity, the amount of fluid gradually decreased, the volume of hyperechoic masses (fibrin) along the inner surface of the capsule increased.

The X-ray picture of the lung abscess before breaking through it in the bronchus was presented as a relatively homogeneous uniform dimming in the corresponding lobe of the lung. After a breakthrough of the abscess cavity in the bronchus, enlightenment corresponding to the size of the abscess cavity containing gas and liquid with a clear horizontal level became noticeable in the center of the abscess.

In patients with destructive pulmonary lesions, diseases established in the early stages of the disease when revealing an extensive site of inflammatory transformation of the lung tissue with destructive changes, it was impossible to determine how the disease will develop in the future: will the development of a large intrapulmonary abscess or bronchopleural complications occur. With a focal-drain form, several small airless foci merged into larger ones. During suppuration of these foci, small areas of somewhat increased echogenicity appeared in the airless part of the lung, in the center of which anechogenic inclusions with a fuzzy contour then surrounded by an echopositive rim appeared. Such sites were often multiple and were also emerging foci of destruction. The site of inflammatory infiltration of the lung tissue was defined as a fragment of an airless pulmonary parenchyma with uneven contours separating this area from the unaffected parts of the lung.

Exudative pleurisy was observed in 2, empyema of the pleura (pyothorax) - in 1 child. The main echographic sign of exudative pleurisy was the separation of the two signals from the pleural sheets with an anechogenic site of a homogeneous or heterogeneous structure, which is the contents of the pleural cavity. The width of the plot depended on the amount of fluid at a given location in the pleural cavity. The minimum amount of fluid in the pleural sinus available for ultrasound imaging was 5 ml.

A purulent form of exudative pleurisy - empyema of the pleura (pyothorax) was diagnosed in 1 child. The empyema cavity usually contained a moderate amount of anechogenic fluid with a hyperechoic suspension, which was limited on the inside by lung tissue and visceral pleura, and with an external parietal pleura and chest wall.

A comparative analysis of X-ray and ultrasound data showed that the minimum amount of pleural effusion that could be detected using the ultrasound method is 5 ml, and X-ray is 50-100 ml, indicating a high resolution ultrasound.

In 1 child with a lung abscess on the MSCT of the lung, there was an increase in the pulmonary pattern and in the lower lobe of the left lung there was a compaction of the lung tissue with fuzzy and uneven contours with an air bronchogram, an air cavity of irregular shape with thick infiltrated walls with a horizontal fluid level with a density

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of up to 26- 34 hu. In 1 child with exudative pleurisy on MSCT, hypo-intensive fluid with a density of up to 10-15 HU was observed in the pleural cavity.

The decay cavity of lung tissue with a horizontal liquid level during x-ray was recorded in 1 child and in 2 children with MSCT study. In 2 patients with MSCT, infiltrative changes and abscessing cavities in the lungs were revealed that were not visualized by X-ray examination, which required correction of the treatment.

In the initial phase of the lung abscessing process, a massive compaction of the lung tissue was noted; in the subsequent phase of the development of lung abscess, a decrease in the density at the center of the infiltrate was observed. Due to the melting of the tissue of the infiltrate, a decrease in the density in its center to 1-23 HU was determined. After the breakthrough of the abscess in the bronchus, visualization of the air cavity was noted, as a rule, with unevenly thickened walls, irregular shape, with fuzzy contours due to perifocal inflammatory infiltration of the lung tissue. The walls of the cavity were uneven in thickness with a “bay-like” internal shape. The drainage bronchus was visualized, after the rejection of necrotic masses and the formation of an abscess capsule, the cavity took a more or less regular rounded shape, uniform wall thickness and even clear internal contours, this phenomenon was determined in 1 child with x-ray, in 3 children with MSCT. The sizes of the decay cavities varied from 8 mm to 40 mm.

An MRI study was carried out in all patients with pneumonia of unspecified localization, with a dubious diagnosis of pneumonia, and in patients requiring re-examination in order to reduce radiation exposure and confirm the diagnosis. An MRI scan was performed on a 1.5T closed-type MRI machine using volumetric interpolated breath hold examination (VIBE) technology with the following characteristics: TR 46 ms, TE 1.8 ms, FA150, effective slice thickness 4 mm Also used was the “true FISP” technology - steady - state free precession sequence, which has a high resolution and signal to noise ratio (S / N - signal to noise ratio) in a liquid medium. To avoid breathing artifacts and reduce the S / N ratio, a slice thickness of 30-35 mm was used with the following parameters: TR 6 ms, TE 3 ms, FA 900 The acquisition time of a triple slice was 4.8 seconds. On MRI, changes in the pleura and pericardial zone were more clearly defined. Small retrocardial pneumonic infiltrates were detected only on MRI, and an increase in tissue density was observed, accompanied by an increase in blood supply, which led to an increase in the level of fluid detected by MRI. Exudative pleurisy was determined on an MRI as a low-intensity signal in T1 images. DWI - diffusion - weighted imaging (diffuse-weighted image) made it possible to differentiate the nature of exudate from transudate. High-intensity signal in T1 images revealed chylothorax.

IV. CONCLUSIONS

The high diagnostic accuracy of radiation research methods for complications of pneumonia was established (digital radiography - 93.1%, CT-97.7%, ultrasound-96.6%, MRI-95.7%), which puts them among a number of highly informative methods of medical imaging with the listed lung diseases. X-ray methods are leading in the diagnosis of lung diseases in children, but their repeated use is accompanied by a significant radiation load on the children's body.

Magnetic resonance imaging and ultrasound diagnostics is a non-invasive and non-ionizing method, therefore, they can be used in young children, both the main diagnostic method and for examination in dynamics. ultrasonic

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monitoring during medical manipulations provides efficiency control in the absence of radiation exposure to the patient and staff.

REFERENCES

[1] World Health statistics 2014. Geneva: World Health Organization, 2014.-№ 45, - 113p.
[2] Buvaeva G.S. Ultrasound diagnosis of changes in the lungs and heart in children with pneumonia and pleuropneumonia: Dis. ... *candidate of medical sciences - M.,* 2007.
[3] Community-acquired pneumonia in children: prevalence, diagnosis, treatment and prevention. *Scientific and practical program.* M., 2011.63 s.
[4] Yusupalieva G.A. Informational content of ultrasound in uncomplicated acute pneumonia. // VI congress of pediatricians of Uzbekistan: *abstract. doc. - Tashkent,* 2009.S. 566-567.
[5] Yusupalieva G.A. Ultrasound diagnosis of pneumonia and their complications in children // *Abstract. Tashkent,* 2009.
[6] Chuchalin A.G. et al. Management plan for patients with mild community-acquired pneumonia. Doctor. 2009. Special issue. S.1-19.
[7] Tatochenko V.K. The rational use of antibiotics in pediatric practice in the treatment of acute infections of the upper and lower respiratory tract // *Consilium medicum.* 2013. - C.5-7.
[8] Olkhova E.B., Buvaeva G.S., Khaspekov D.V. Integrated ultrasound examination for destructive pneumonia in children / *Materials of the II International Congress 121. Nevsky Radiological Forum - 2005 "Science - Clinic"* April 9-12, 2005, St. Petersburg. 2005. P.302-304.
[9] Belova I.B. Radiation diagnosis of complicated pneumonia and other lung diseases / Belova IB, Staroseltsev AA, Gusev AS // Scientific notes of the Oryol State University. *Series: Natural, technical and medical sciences.* 2013№6 (56). - S. 192-197.
[10] Yusupalieva G.A. The information content of ultrasound in the early diagnosis of complicated pneumonia in children // *Pediatrics. - Tashkent,* 2008. - No. 3-4. - S. 33 - 36.
[11] Belova I. B. Possibilities of multispiral computed tomography in the diagnosis of pneumonia / Belova IB, Kitaev VM, Staroseltsev AA // *Bulletin of the National Medical and Surgical Center.* N.I. Pirogov. - 2014. - T.9, No. 4. - WITH.
[12] Shchitinin V.E., Khaspekov D.V., Olkhova E.B., Topilin O.G., Buvaeva G.S. Ultrasound diagnostics in the treatment of destructive processes in the lungs in children / *Mater. III Russian Congress "Modern Technologies in Pediatrics and Pediatric Surgery"* October 26-28. 2004 M.S. 533-534.
[13] Rhedin S. A. et al. Introducing a New Algorithm for Classification of Etiology in Studies on Pediatric Pneumonia: Protocol for the Trial of Respiratory Infections in Children for Enhanced Diagnostics Study //*JMIR research protocols.* – 2019. – Т. 8. – №. 4. – С. e12705.
[14] Spence H. et al. Childhood pneumonia diagnostics: community health workers' and national stakeholders' differing perspectives of new and existing aids //*Global health action.* – 2017. – Т. 10. – №. 1. – С. 1290340.
[15] Skřičková J. Nosocomial pneumonia //*Vnitrnilekarstvi.* – 2017. – Т. 63. – №. 7-8. – С. 518-526.
[16] Xie Y. et al. Identification of early-stage usual interstitial pneumonia from low-dose chest CT scans using fractional high-density lung distribution //Medical Imaging 2017: Computer-Aided Diagnosis. – *International Society for Optics and Photonics,* 2017. – Т. 10134. – С. 1013408.
[17] Ando A. et al. The Impact Of CT-Detected Usual Interstitial Pneumonia Pattern As The Decision-Making Factor For Treatment Of Lung Cancer //B43. ILD: CLINICAL STUDIES, REGISTRIES AND MORE. – *American Thoracic Society,* 2017. – С. A3452-A3452.
[18] Mendoza O. M. et al. Diagnostic agreement of usual interstitial pneumonia (UIP) on chest CT between chest radiologists using current guidelines. – 2017.
[19] Ekinci A. et al. MRI of pneumonia in immunocompromised patients: comparison with CT //*Diagnostic and Interventional Radiology.* – 2017. – Т. 23. – №. 1. – С. 22.
[20] Kauczor H. U., Wielpütz M. O. (ed.). MRI of the Lung. – *Berlin Heidelberg: Springer,* 2018. – С. 518.

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