X-ray examinations of newborns

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Abstract. At the present time, the basis of instrumental diagnostics of atelectasis is lung radiography. In the case of preterm infants, it should be performed immediately after birth, and then regularly throughout the entire nursing period. The purpose of the project, within the framework of which this development is carried out, is the creation of an original domestic digital low-dose technology for X-ray examinations in neonatology, including in non-stationary conditions.

Modern medical practice shows that up to 10 % of the total number of newborns are born annually prematurely because of spontaneous premature births or because of planned artificial termination of pregnancy in later periods.

According to the definition of the World Health Organization since 1974, and in Russia since 2013 [Order of the Ministry of Health and Social Development of Russia No. 1687n], newborns are considered viable at a body weight of 500 g and above. Such a child fits in the palm of an adult and, unfortunately, at the time of birth has a whole set of diseases. One of the most dangerous is atelectasis of the lung – incomplete expansion of the lung tissue in a restricted area or in the entire lung.

At the present time, the basis of instrumental diagnostics of atelectasis is lung radiography. In the case of preterm infants, it should be performed immediately after birth, and then regularly throughout the entire nursing period. At the same time, during nursing, the child is in a special box – an incubator (cuvette), in which the necessary regime of temperature, humidity, oxygenation, feeding and introducing the necessary drugs through special probes is maintained. Accordingly, such children should not be X-rayed in stationary X-ray rooms, but in maternity halls, emergency units, intensive care units and, in some cases, during transportation of the newborn from the maternity home to the perinatal center.

The radiographic methods standardized in Russian medicine not allows conducting X-ray studies of premature babies in the described – unspecialized conditions. The main reasons for this are:

– the lack of technical diagnostic tools that make it possible to obtain X-ray images of such specific objects as the thoracic area of a child weighing 500 g, having the necessary informativeness;
– the lack of methods for conducting X-ray studies in neonatology in unspecialized conditions, including methods of patient placement, mode selection tables, etc.

It should be specially noted, that at present time there are no commercially available domestic or foreign X-ray machines that allow conducting X-ray studies in the described conditions.

At the same time, conducting digital radiography for newborns is very much in demand. According to the Children’s City Hospital No.1 (St. Petersburg), only in its intensive care units about 4500 roentgenological procedures are performed every year in 2 or 3 projections. In total, up to 10 thousand X-ray images per year are performed.
Currently, these studies are conducted on domestic or foreign X-ray machines that are practically not adapted to the tasks and conditions of resuscitation of newborns with pathologies. Accordingly, the medical personnel and the nearby patients are subjected to an additional radiation load.

The purpose of the project, within the framework of which this development is carried out, is the creation of an original domestic digital low-dose technology for X-ray examinations in neonatology, including in non-stationary conditions. Studies conducted in conjunction with specialists from the Almazov National Medical Research Center of the Ministry of Health of the Russian Federation and of the Children's City Hospital No.1 showed that practically all the listed requirements for organizing X-ray diagnostic studies in unspecialized conditions and, first of all, neonatology, are met by Microfocus X-ray radiography [1]. Its main distinguishing features are:

– the use of X-ray machines with a focal spot size of an X-ray tube of less than 0.1 mm;
– 1.5–2 fold increase in voltage at the X-ray tube and a decrease in the focal distance of 3–5 times as compared to standard X-ray technique [2, 3].

To implement this method in the first stage of the project, a specialized digital X-ray diagnostic complex was used as a prototype, including the X-ray device of the family PARDUS and X-ray imaging systems based on a photo-stimulated screen in the portable design. The design of the first domestic portable device “PARDUS-R” allows you to obtain X-ray images without the use of a stationary tripod. The X-ray staff performs the survey, holding the device in its hand and being in a radiation-safe environment (figure 1) [4].

![Portable X-ray device “PARDUS-R”](image1.png)

Figure 1. Portable X-ray device “PARDUS-R”.

The approbation of the technique was carried out on the basis of a multidisciplinary children's hospital. Figure 2 shows X-ray images of the thoracic region (Patient P., age – 7 months, weight – 3.5 kg) obtained in a stationary X-ray cabinet (figure 2(a)), and obtained “at home” in the same patient (figure 2(b)) using the prototype of the complex.

![X-ray images of the chest of the newborn](image2.png)

Figure 2. X-ray images of the chest of the newborn.
On X-ray images obtained under non-stationary conditions, the lung tissue, the contours of the heart and the dome of the diaphragm are clearly traced. Figure 3 shows a picture of the lumber region, also obtained in non-stationary conditions (in the ward).

![Figure 3. X-ray image of the newborn’s lumber.](image)

All bone structures are visualized clearly. According to experts, the information content of all X-ray images obtained in non-specialized and non-stationary conditions is almost not inferior to the X-ray image obtained in the hospital.

Thus, the results of the studies open up the prospect of using the technique of Microfocus X-ray radiography with portable technical means for researching newborns.

**Acknowledgments**

The work is supported by the Federal Targeted Program “Research and Development in Priority Areas for the progress of the Russian Science and Technology Complex for 2014-2020” (Event 1.3) under Contract No. 14.578.21.0262 “Digital acute-focus X-ray diagnostic neonatal complex”.

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