Low Dose Radiographic System for Pediatrics

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***Abstract* — The paper deals with a specialized digital X-ray system for use in children's trauma centers and maternity hospitals. The basic requirements for such equipment: high contrast and spatial resolution of the images with minimal radiation exposure to the baby. It is proposed the set of equipment which meets these requirements: the microfocus X-ray generator (output power of less than 50 W, the focal spot of less than 50 microns), a special tripod and a digital receiver on a array of the photodiode matrices , which allows to obtain a digital image with a spatial resolution to 9.0 line pairs per millimeter with entrance exposure dose in the plane of the receiver is less than 500 mR**

***Index Terms* — pediatrics, low-dose radiographic system, high contrast and spatial resolution, microdose radiation exposure.**

I. PURPOSE

In pediatric radiology patients are significantly different from each other both by means of size, and on the density structure. On the one hand, young children have not formed bone structure, geometry objects of study are small, which requires a high contrast and spatial resolution of the images. On the other hand, the younger the child, the more sensitive it`s organism to radiation. This makes ultrasonic method a preferred application when examining young children. However, in many cases, X-ray method should be used, & it is necessary to minimize the effects of radiation to the patient. The purpose of the work was to create a specialized X-ray equipment to obtain diagnostic images with high contrast and spatial resolution at microdose (several hundreds of micro-roentgen) radiation exposure to the patient.

II/ MATERIALS AND METHODS

Digital X-ray system consists of a small mobile universal tripod with a special table-stand, a micro transmitter and a highly sensitive digital receiver based on photodiode matrices array.

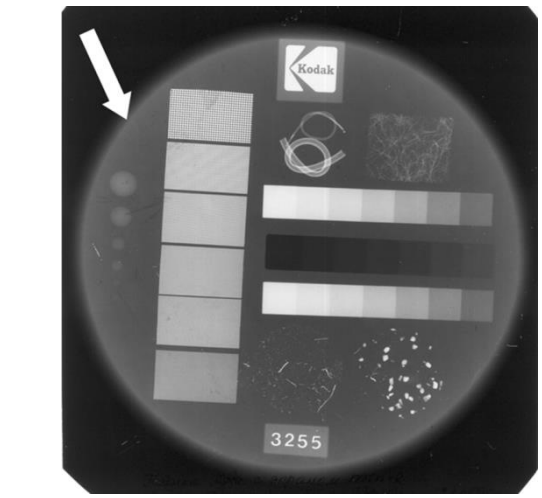
By changing the position of a radiolucent tabletop between the transmitter and the receiver X-ray studies of objects in X-ray mode, zoom in both the horizontal and vertical planes could be performed (Fig.1a,b).

a b

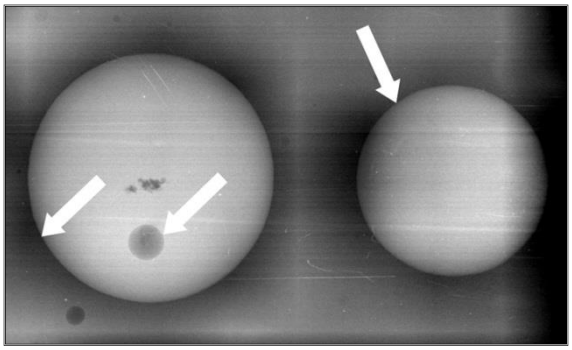
Fig. 1. Low-dose X-ray system:
a – in horizontal position, b- in vertical position

III. RESULTS

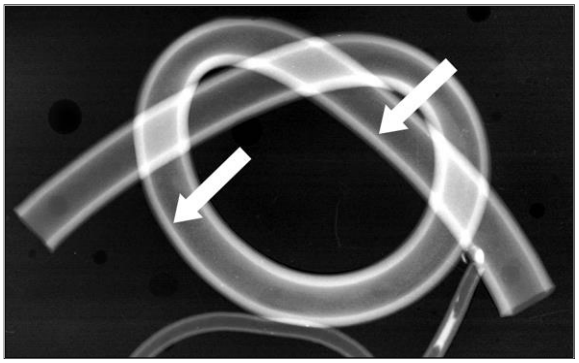
Small-sized mobile radiographic system that provides high-quality digital images of X-ray generator with a power less than 50 Wt was implemented. The subject can be located directly at the receiver and away from it.



a



b



c

Fig. 2 Panoramic X-ray image of mammographic phantom (a) and X-ray images of some of its parts made in magnification mode (b,c)

By changing the distance from the radiation source to the examinated object (f1) and the distance from the object to the receiver (f2), you can change the coefficient of magnification Cm= (f1 + f2) / f1. Use the zoom mode allows you to change the spatial resolution of the images. The larger the zoom, the higher the spatial resolution, but smaller field of view. For illustration, Figure 2 shows a snapshot of mammographic phantom, and the 2b - detailed pictures of the individual parts, made in zoom mode.

At the X-ray images of mira images with a spatial resolution of up to 9.0 line pairs per millimeter were obtained. In this case, the exposure dose in the plane of the receiver does not exceed 500 mR (microdose mode). To increase the sensitivity (lower dose) there is a binning mode in the digital receiver, where the signal of several pixels are merged into one. Binning modes and zoom extend the operator`s opportunities to choose the optimal ratio "image quality-dose", which is especially important in significant variability of research objects. The possibility of a detailed analysis of the integrity of bone tissue using microfocus X-ray diffraction in combination with the assessment of soft tissue injuries using ultrasound allows to make more accurate diagnosis of traumatic injuries. A low radiation load on the object of study are responsible for the feasibility of using Low dose x-ray systems to take the X-ray images of babies who have increased sensitivity to ionizing radiation.

IV. CONCLUSION

Application of considered digital microfocus radiographic system is most promising in hospitals for x-ray examinations in infants and in children's emergency station in combination with ultrasound scanners.