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The First Experience in Application of Tomosynthesis in the Diagnosis of Non-Palpable Breast Cancer.

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ABSTRACT

The relevance of studying the incidence of breast cancer is a problem of modern health care due to a steady growth of morbidity, including those of malignant character. About 1 million new cases of breast cancer are detected yearly in the world, predicting growth in the number of cases by 2014 to 1.45 million. Currently, a certain progress has been made in the diagnosis of early forms of the disease through the introduction of modern technologies of beam diagnostics. The most effective among them is an X-rays examination. However, there is a number of unresolved problems in the differential diagnosis of non-palpable breast formations because of their early symptoms non-specificity. In this regard, new technologies are developed that can enhance these capabilities. Despite the widespread use of mammography, there is still a number of limitations. This is primarily due to the complexity of interpreting the images of mass lesions because of superimposed structural elements of breast tissue located in different planes. Breast tomosynthesis is a new technology that allows avoiding these disadvantages. Using a flat panel X-ray detector and rotating the tube in relation to the image receiver, we perform a series of low-dose exposures at different angles, converting further the received information into a series of tomograms.

Keywords: breast cancer, tomosynthesis, digital mammography

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INTRODUCTION

Objective of research: to improve the diagnosis results of non-palpable breast formations with the use of tomosynthesis.

To achieve the set objective the next tasks had been completed:

- Analysis of different types of non-palpable breast cancer, the most difficult image to interpret with tomosynthesis, and
- A comparative analysis of visual information in the non-palpable breast formations on the basis of digital mammography, tomosynthesis-based mammography, and ultrasound.

MATERIALS AND METHODS

In order to evaluate the information content of tomosynthesis, we conducted a survey of 250 women in the outpatient environment. The study enrolled women aged 30 to 70 years, which made it possible to study the features of the image on the sections of the structural elements of different densities, typical of women of reproductive age, as well as those with fatty involution. All patients had no complains of the presence of breast induration, and no breast nodularity was clinically detected.

A set of studies included physical, x-ray, ultrasound non-invasive and invasive methods of investigation, as well as cytological and histological studies. X-rays had the highest value for the specifying diagnostics. Digital mammography was performed in two standard projections - craniocaudal and mediolateral. The images were evaluated on the doctor's workstation with a monitors resolution of 3 megapixels.

X-ray examination was conducted on Selenia Dimensions by Hologic in «COMBO» mode (during the single-stage compression both standard mammography and tomosynthesis were performed). Under tomosynthesis mode, the apparatus performed a series of 15 shots with the X-ray tube rotation in the range of -7.5 to +7.5 in relation to the image receiver (Figure 1). The doctor's workstation displayed the obtained data in three variants: digital mammograms, tomograms series of 15 images taken from different angles, and the series reconstruction. After the mathematical processing of the digital data, a series of breast images with a slice thickness of 1 mm was shown on the screen.

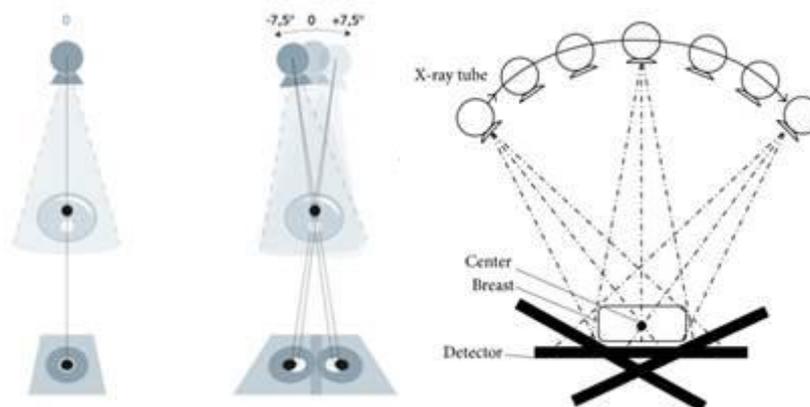


Fig. 1. Breast tomosynthesis scheme

All standard image-processing tools were available for viewing each section: a magnifying glass, an inversion, brightness and contrast change, a ruler, etc.

The tomosynthesis-mode images were taken under reduced exposure with decreasing the number of mAs, but with the same values of the X-ray tube capacity (kV) as compared to the standard digital mammography. This allowed us not to increase the effective dose to the patient. The breast tissue dose in the tomosynthesis mode averaged 1.2 mGy, as well as in case of standard mammography.

RESULTS

Breast tomosynthesis procedure.

All patients underwent mammography of both breasts in two projections in a “COMBO” mode: subject to the individual level of breast compression, we consistently performed the standard mammography, followed by tomosynthesis, and further the automatic breast decompression. On the workstation, the doctor could display on one monitor the standard mammograms, and on the second the series of reconstructed breast sections. Thus, it was possible to compare the obtained images and select the necessary sections, where the detected formation visible on the standard mammogram was clearer.

The standard mammograms were examined according to the scheme. First, an image was assessed in its original size. Two monitors displayed both breasts first in frontal projection, and then in oblique one. Further, the upper outer, upper inner, lower outer, and lower inner quadrants were assessed with 2-fold increase. The existing zones of interest were assessed by using the available image processing tools. Further, the tomosynthesis mode was used with the same processing and viewing tools.

To compare the informational value of tomosynthesis and other methods of investigation in patients with non-palpable breast formations we examined 250 women, with non-palpable formations detected in 150 cases. Eighty-eight patients had fibroadipose involution, 162 had various mastopathy diffuse changes. Nodular formations and calcified foci against the diffuse changes were detected on the conventional mammograms in 205 patients (80%), by tomosynthesis - in 215 (86%), and by ultrasound - in 180 women (72%).

Among 150 patients with non-palpable breast formations the signs of malignancy against the diffuse changes were detected on standard mammograms in 55 (93%) women, by tomosynthesis - in 58 patients (97%), and by breast ultrasound - in 45 cases (75%).

Thus, the reconstruction of the image has provided an additional information to standard mammography in 5 patients, whose non-palpable formations were not detected because of their solid background. The tomosynthesis allowed excluding in 2 patients the areas on a series of sections that resemble a stringy restructuring, as they formation has contributed to the imposition of the images of breast structural elements during standard digital mammography (Fig. 2, 3).



Fig. 2, 3. Patient M., 46 years old. Right breast mammography. Breast cancer right, tissue restructuring. 2D (A) and 3D (B) images

The reconstruction mode allowed specifying the nature of the boundaries of the detected non-palpable formations. Thus, the mammograms of 17 women showed formations with indistinct (8.4%) radiate boundaries (4.0%). Viewing the cross-sectional images, the boundaries of these formations were clearly visualized throughout the entire volume, making it possible to eliminate, and suspect in 2 patients an infiltrative growth of the detected formations, due to image definition on each section (Fig. 4, 5).

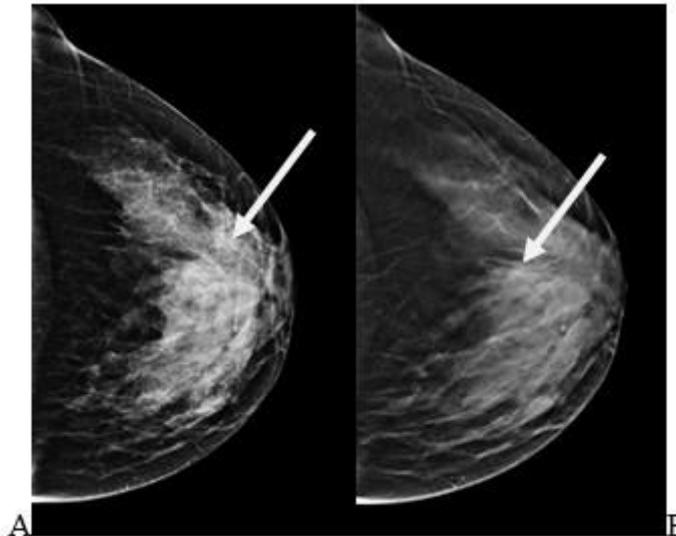


Fig. 4, 5. Patient M., 48 years old. Left breast mammography. 2D (A) and 3D (B) images. Tissue restructuring – a radial scar

The difficulties of the differential diagnosis arose in identifying the areas of microcalcification clusters. The main task defining the further managing tactics for these patients is the assessment of the formations location and nature. 20% (33) of women had isolated calcifications detected in breast. The areas of microcalcification clusters on mammograms were detected in 10% of cases (16 women), and by tomosynthesis - in 15% (24 patients). The accumulation of microcalcifications in 3 patients was due to the imposition of several sections of calcifications on each other at different sections. Seven patients had the grouped microcalcifications on different sections better visualized due to tissue superposition exclusion [1-10].

CONCLUSION

Application of tomosynthesis in X-ray diagnostics of non-palpable breast formations enhances the potential of the X-ray method, improves the detection rate of non-palpable cancer, improves by 4% the differential diagnosis of diseases accompanied by the breast tissue restructuring, improves by 5% the diagnosis of diseases accompanied by the accumulation of calcifications, eliminates the need for additional research (spot mammography, additional setups), reduces the number of invasive procedures with hyperdiagnosis exclusion in some cases, and increases the possibility of conducting the conservative operations.

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