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Digital tomosynthesis in breast cancer diagnostics (literature review)

Relevance: *Breast cancer is the most common malignant neoplasm among wom-en in our country. Mammography is currently the method of choice in breast can-cer diagnostics. However, it has limitations associated with the imposition of breast tissue layers, which makes it difficult to identify lesions and leads to a mis-diagnosis. Breast tomosynthesis is a tomographic technique in which the effect of tissue superimposition is significantly reduced due to layer-by-layer scanning.*

The purpose of this study *was to review the capacity of tomosynthesis in the di-agnosis of breast cancer.*

Results: *The combination of tomosynthesis with a synthesized image is the best technology for screening because it offers the best combination of efficiency and radiation dose. Advantages include greater diagnostic accuracy due to both in-creased sensitivity and specificity, and a significantly less need for additional mammography projections (targeted mammography, targeted mammography with magnification).*

Conclusions: *Tomosynthesis as a diagnostic method significantly exceeds the method of mammography. The higher informative value of the results provided by tomosynthesis reduces the frequency of false-negative and false-positive radio-logical conclusions.*

Keywords: *Digital tomosynthesis, mammography.*

Introduction: Breast cancer (BC) is the most common malignant neoplasm among women in Kazakhstan [1]. Mammography is currently the method of choice for radiation diagnostics in the screening of asymptomatic women and diagnostics of women with complaints [2]. However, the imposition of breast tissue limits the possibilities of this method, preventing the detection of formations and leading to a delay in diagnosis. Recent developments brought to life new methods aimed at increasing the sensitivity of mammography in BC detection. Breast tomosynthesis is a tomographic technique based on digital mammography, in which the detector moves in an arc along with the mammary gland, and a series of low-dose images is taken from various points. Further reconstruction of the acquired images in a 3D computer image reduces the effect of tissue superimposition.

Materials and Methods. A search of literature sources for 1998-2020 was performed in PubMed using the keywords "tomosynthesis," "mammography." 26 literary sources meeting the selection criteria were included in the literature review; those were the original scientific articles containing the analysis of tomosynthesis results in BC diagnostics.

Results: *The use of tomosynthesis as a screening tool.* Despite all its advantages, traditional mammography has certain limitations. According to the literature, standard screening methods can return false-negative results in 15-30% of patients with BC [3]. The main limitation is the superimposition of breast tissue, which can complicate the detection of formations and lead to delayed diagnosis (Figure 1).

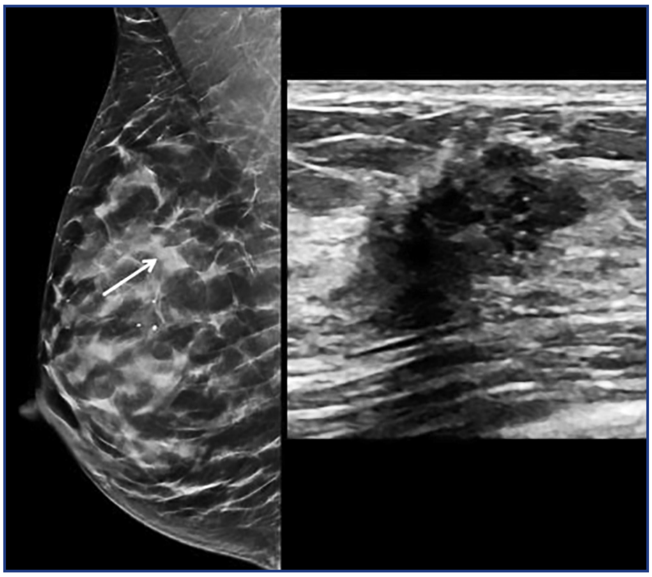

Figure 1 – Areas of dense fibroglandular tissue on the mammogram intercept a nodular formation indicated by an arrow (left). This nodal formation on the sonogram (right). Histologically invasive ductal carcinoma

In women with dense breast tissue, the percentage of missed cancers is even higher [4-6]. The results of several successive retrospective and prospective screening studies reveal the potential of tomosynthesis in BC screening [7-11]. Also, the combination of tomosynthesis and mammography can reduce the number of false-positive screening results and increase the BC detection rate compared to mammography alone [12]. However, when tomosynthesis and digital mammography are applied together, the x-ray dose received by women is almost 2.25 times higher than during mammography alone [13]. The use of a 2D-image synthesized by the computer from the tomosynthesis data set can solve the problem of increased radiation exposure. The earliest studies reported a lower sensitivity and comparable specificity when comparing a synthetic 2D-mammography with traditional mammography [14]. Today, this function (synthetic 2D-imaging) is available in all tomosynthesis systems, and each manufacturer uses various tomosynthesis technologies to increase the accuracy of imaging (Figure 2). For example, narrow-angle tomosynthesis with shorter scan times is useful for detecting calcifications, while wide-angle tomosynthesis has higher depth resolution and is applicable for detecting tumor formations [15-16].

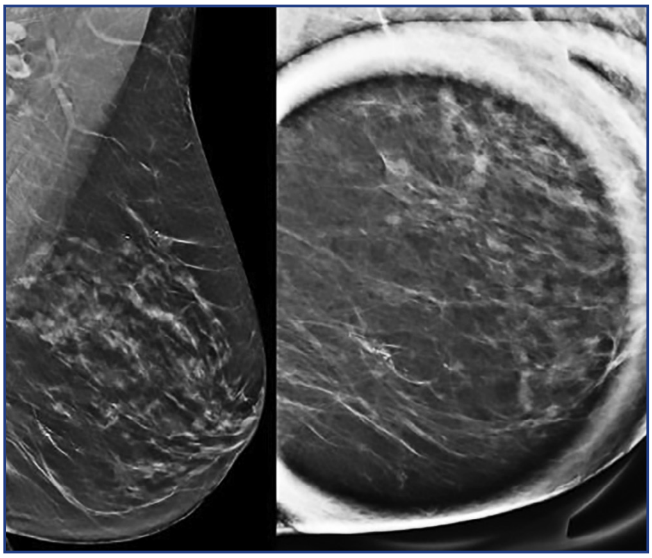

Figure 2 – The use of tomosynthesis to detect microcalcifications: Linear-branched microcalcinates with a linear distribution on the slice of tomosynthesis (right) and targeted mammography with magnification (left)

Cohen *et al.* have evaluated the effectiveness of three BC screening modes: tomosynthesis with a synthesized 2D-image, tomosynthesis in combination with conventional digital mammography, and traditional digital mammography [17]. About 800,000 mammograms were evaluated, 3,466 malignant tumors were diagnosed. Visualization was made using Selenia (Hologic) devices, and the synthesized image was created using C-View (Hologic) technology. Two modes involving tomosynthesis (tomosynthesis + synthesized image, tomosynthesis + digital mammography) showed better results than digital mammography. They allowed reducing the recall rate and increasing the total cancer detection rate and the invasive cancer detection rate (p<0.0001). Besides, the use of tomosynthesis increased the positive predictive value of screening. The favorable prognostic value of a biopsy was higher in the case of tomosynthesis with synthesized imaging than in the combination of mammography + tomosynthesis (40.7% and 34.5%, respectively, p=0.026). However, no difference was revealed in recall rate, total cancer detection rate, or invasive cancer detection rate. The *in situ* cancer detection rate was higher when using mammography with tomosynthesis compared to mammography alone (p=0.031), but in general, there was no statistically significant difference in cancer detection between all three screening modes (p=0.18 and p=0.686, respectively).

The results of this study indicate that the combination of tomosynthesis with the synthesized image is the best choice for screening since it offers the best combination of efficiency and radiation dose.

The use of tomosynthesis as a diagnostic method. Tomosynthesis improves the quality of BC diagnostics. Advantages include higher diagnostic accuracy thanks to increased sensitivity and specificity, as well as a marked reduction in the need for additional mammography projections (targeted mammography, targeted mammography with magnification).

Studies have shown that tomosynthesis can be used as an alternative to traditional diagnostic research methods. Thus, several works demonstrated its equivalent efficacy compared to digital mammography [9, 18-21].

Brandt et al. evaluated 158 non-calcified anomalies to demonstrate that tomosynthesis diagnostic accuracy was not inferior to mammography [22]. Peppard et al. compared or the effectiveness of targeted mammography and tomosynthesis for assessing non-calcified lesions and determined that performing tomosynthesis in two projections was sufficient to assess the formation contours. The informative value of such examination was higher than of targeted mammography [23].

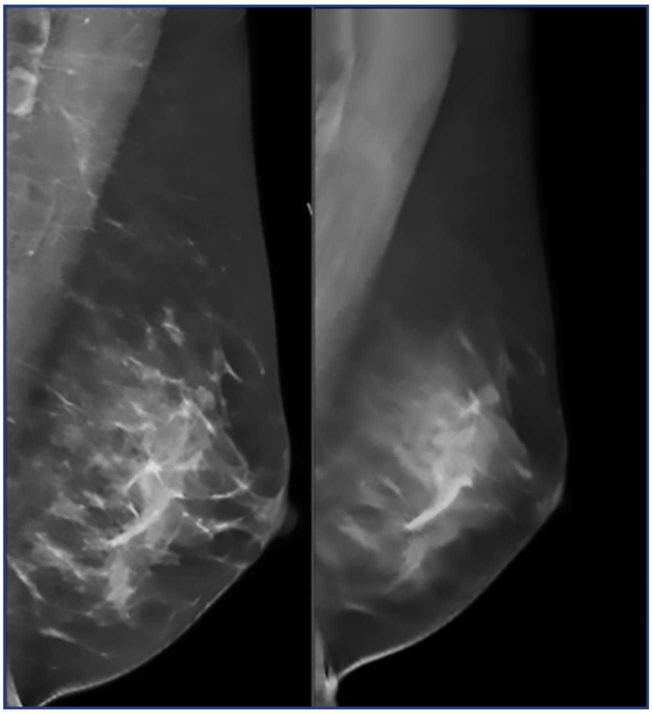

Figure 3 – The use of tomosynthesis to detect mammographically occult architectural distortions: two areas of architectural distortions are clearly visible on the sections of tomosynthesis (left), but are not clear on mammograms (right). Histologically-radial scar

Tomosynthesis provides clear advantages in identifying various types of X-ray changes, primarily, architectural distortions, asymmetries, and uncalcified formations (Figure 3). According to reports, breast architectural distortions account for 12-45% of missed cases of BC [24, 25]. Partyka *et al.* have examined the cases of architectural distortions and found that 73% (19 of 26 cases) were visible only by tomosynthesis [26]. In six of the remaining seven cases, the violations were better visible on sections of tomosynthesis than on digital mammography images. In mammographically occult cases of architectural distortions, the cancer detection rate using tomosynthesis was 21%, and the positive prognostic value of the biopsy was 44%. Improving the detection of architectural distortions is especially essential for BC diagnostics since such disorders are associated with a high positive predictive value regarding cancer detection [27]. Mariscotti *et al.* have examined 83 women with 107 cases of invasive lobular carcinoma to reveal that the interpretation of tomosynthesis images in combination with standard digital mammography (compared to digital mammography only) improved the detection of invasive lobular carcinoma manifested by architectural distortions (84% vs. 65%) or by a formation (89% vs. 70%). It improved the efficiency of both experienced radiologists and radiologists with less experience; a higher increase in efficiency was observed in less experienced radiologists. Multifocal, multicentric, as well as bilateral cancer, was more often detected by the combination of digital mammography + tomosynthesis [28].

Conclusion: Thus, tomosynthesis, as a screening and diagnostic tool, significantly exceeds mammography. Tomosynthesis provides more informative results and, consequently, offers less false-negative or false-positive radiologists' opinions.

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