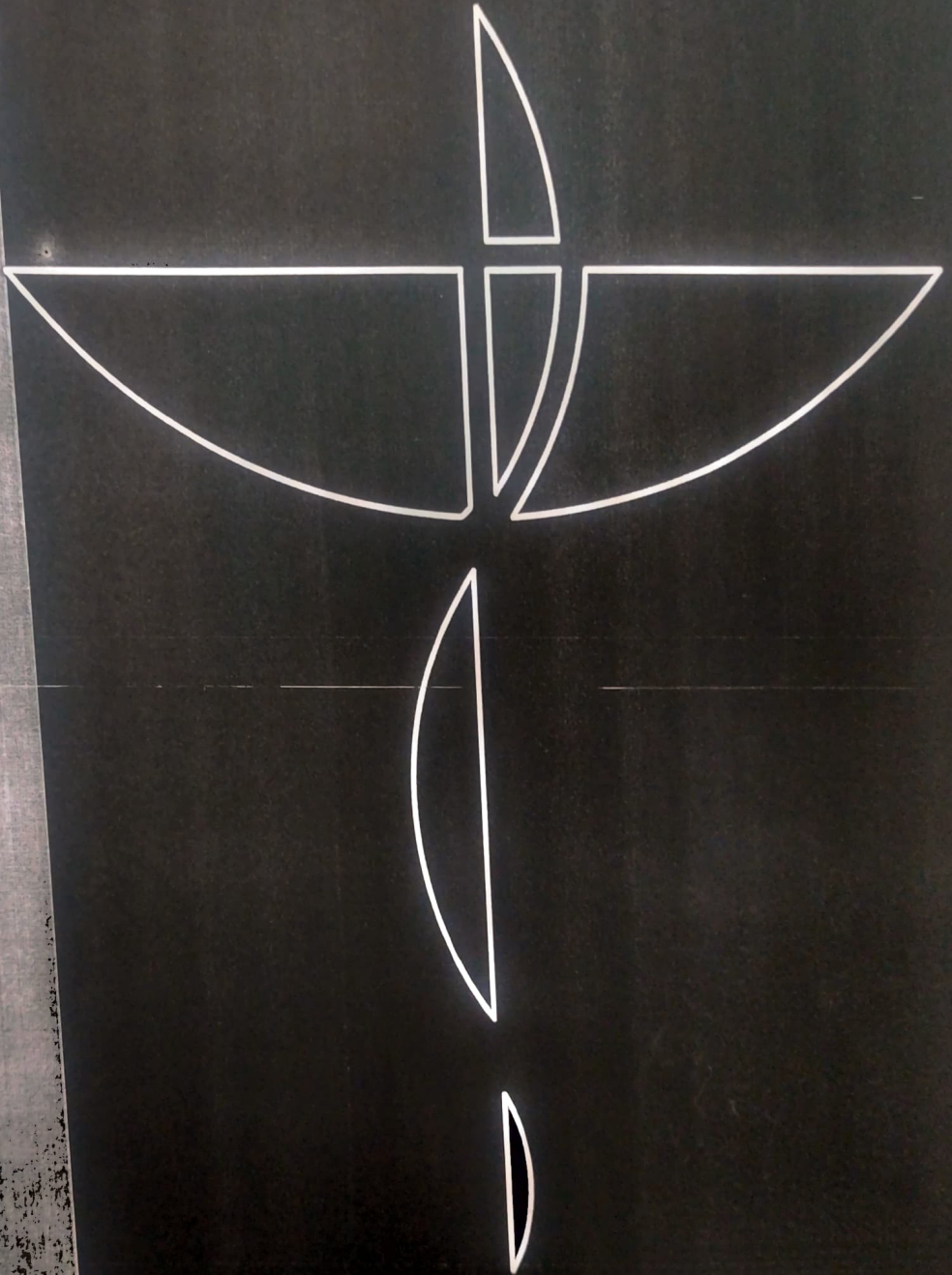




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COMPARATIVE EVALUATION OF 2D MAMMOGRAPHY AND TOMOSYNTHESIS IN DIAGNOSTIC COHORT

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Abstract

Accurate radiological evaluation is critical in the diagnostic workup of women presenting with clinical breast symptoms. While digital breast tomosynthesis – DBT, regarding 3D mammography (tomosynthesis) has shown benefits in screening population, its role in symptomatic patients requires further evaluation. The purpose of the study was to compare diagnostic performance of 2D mammography and tomosynthesis in detecting breast cancer among symptomatic women. The retrospective study included 75 women (at age 63 ± 10 years) referred for imaging due to clinical breast changes, that underwent both, 2D mammography and tomosynthesis. Final diagnosis was established by histopathology and clinical follow-up. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated and compared between the two modalities. Among the 75 patients, 59 were diagnosed with breast cancer and 16 had benign findings. Sensitivity was higher for tomosynthesis (93.2%) than for 2D mammography (72.4%) ($p < 0.05$). Specificity was similar between modalities (43.8% for 3D vs. 47.1% for 2D) and PPV was slightly higher for 3D (85.9%) compared to 2D (82.4%). Notably, tomosynthesis demonstrated a significantly higher NPV (63.6%) than 2D (33.3%). In a diagnostic population, tomosynthesis outperforms 2D mammography in sensitivity and NPV, supporting its use as preferred modality for evaluating women with breast symptoms. These findings suggest a potential for improved diagnostic confidence and reduced false negative values in symptomatic cases. Thus, implementing tomosynthesis in routine clinical practice is preferable for breast cancer detection in women with clinical symptoms, which lead to better diagnostic performance and lower mortality rate, respectively.

Keywords: breast cancer; 2D mammography; tomosynthesis; symptomatic breast lesions.

СПОРЕДБЕНА ЕВАЛУАЦИЈА НА 2Д МАМОГРАФИЈА И ТОМОСИНТЕЗА ВО ДИЈАГНОСТИЧКА ГРУПА НА ПАЦИЕНТИ

Апстракт

Точната радиолошка евалуација е од клучно значење во дијагностиката кај жените со клинички симптоми на дојката. Додека за дигиталната томосинтеза на дојка – ДТД, 3Д мамографија (томосинтеза) е докажана нејзината предност во скринингот, за докажување на улогата во дијагнозата кај пациентите со симптоми, потребни се понатамошни испитувања. Целта на студијата беше да се споредат дијагностичките перформанси на 2Д мамографијата и на томосинтезата при откривањето на рак на

дојка кај жени со симптоми. Ретроспективната студија опфати 75 жени (63±10 години) упатени на снимање поради појава на симптоми. Сите беа подложени на двете методи, 2D мамографија и томосинтеза. Конечната дијагноза беше поставена со хистопатолошкиот наод и со клиничкото следење. Сензитивноста, специфичноста, позитивната предиктивна вредност (ППВ) и негативната предиктивна вредност (НПВ) беа пресметани и споредени помеѓу двата модалитети. Од 75 пациенти, на 59 им бил дијагностициран рак на дојка, а 16 биле со бенигни наоди. Сензитивноста покажа повисока вредност за томосинтезата (93.2%) отколку за 2D мамографија (72.4%) ($p<0.05$). Специфичноста беше слична помеѓу модалитетите (43.8% за томосинтеза наспроти 47.1% за 2D мамографијата). ППВ беше малку повисока за томосинтезата (85.9%) во споредба со 2D мамографијата (82.4%), додека томосинтезата покажа значително повисока НПВ (63.6%) во споредба со 2D мамографијата (33.3%).

Во дијагностицирањето на пациентите, томосинтезата ја надмина 2D мамографијата по сензитивноста и негативната предиктивна вредност, укажувајќи на нејзината употреба како подобар модалитет за евалуација на жените со симптоми на дојка. Овие наоди укажуваат на нејзиниот потенцијал за поголема сигурност во дијагностиката и за намалените лажни негативи вредности кај симптоматските случаи. Така, воведувањето на томосинтезата во рутинската клиничка пракса може да придонесе при откривањето на ракот на дојката кај жените со клинички симптоми, што доведува до подобри дијагностички перформанси и истовремено помала стапка на смртност.

Клучни зборови: рак на дојка; 2D мамографија; томосинтеза; симптоматски лезии на дојка.

Introduction

Breast cancer remains the most frequently diagnosed cancer in women worldwide and is a leading cause of cancer related mortality. Early and accurate detection is essential for improving prognosis and reducing treatment burden (10, 12, 13). Imaging plays a central role in the diagnostic pathways, particularly for patients presenting with clinical signs or symptoms such as palpable lumps, nipple discharge, or skin changes. Conventional two-dimensional (2D) mammography is the most widely used imaging modality for breast cancer detection (6, 18). However, its performance can be limited by overlapping tissue structures, especially in women with dense breast tissue, leading to false negatives or unnecessary recalls (4, 5, 8, 15).

Digital breast tomosynthesis (DBT) or three-dimensional mammography (tomosynthesis) has emerged as a complementary technique that reduces tissue overlap by acquiring multiple images through the breast at different angle, reconstructing a 3D image (1, 2, 19). Numerous studies have demonstrated improved cancer detection rates and reduced recall rates with 3D tomosynthesis in screening settings (3, 7, 9, 21, 22). However, there is less evidence comparing 2D mammography and tomosynthesis in diagnostic populations – patients already presenting with breast changes where the present probability of disease is higher. In such settings, maximizing diagnostic sensitivity and minimizing false negative values are particularly important.

The objective of this study was to assess and compare the diagnostic performance of 2D mammography and tomosynthesis in a symptomatic women population. We specifically analyzed and compared sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) in a cohort of women presenting with breast symptoms, using histopathological findings.

Material and methods

The retrospective diagnostic accuracy study was conducted at the General City Hospital "8th of September" in Skopje, Republic of North Macedonia, evaluating imaging findings in a cohort of 75 women who presented clinical breast symptoms in a period of 12 months. All patients were referred for radiological evaluation due to palpable masses, nipple discharge, skin retraction, or other clinical breast changes. Patients undergoing routine screening without symptoms were excluded.

All participants underwent both, full-field digital 2D mammography and tomosynthesis as part of their diagnostic workup. Thus, inclusive criteria were: female patients, above age of 40 years old, patients underwent 2 imaging modalities of 2D mammography and tomosynthesis, patients underwent breast biopsies and given to histopathology analysis and patients with follow up in the period up to 12 months. Exclusive criteria were male patients, patients younger than 40 years old, pregnant and breast-feeding women, and patients with breast implants.

Imaging was performed using Siemens Healthineers Revelation, Germany, following standard clinical protocols, where the radiation dose for one breast with 2D mammography was 2-3 mGy in 2 projections (Cranio-Caudal and Medio Lateral Obliquus), while for tomosynthesis was 3-4 mGy in all projections. Final diagnosis was established based on histopathological analysis of biopsy samples for all suspicious lesions and by follow up for those without biopsy in a 12-month period. These diagnoses were used as the reference standard for classification of imaging findings as true positive (TP), false positive (FP), false negative (FN), or true negative (TN).

Diagnostic performance metrics were calculated for both, 2D and 3D modalities, including sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). Each metric was computed using standard 2x2 contingency tables: Sensitivity = $TP / (TP + FN)$; Specificity = $TN / (TN + FP)$; PPV = $TP / (TP + FP)$; NPV = $TN / (TN + FN)$. Comparison between the two modalities was descriptive, as all patients underwent both imaging methods. McNemar's test was considered for paired proportions. Data analysis was performed using SPSS software package.

Results

A number of 75 women with clinical breast symptoms were included in the analysis. The mean age of the participants was 63 ± 10 years and all underwent both, 2D mammography and tomosynthesis as part of their diagnostic evaluation.

On Figure 1, there is a suspicious lesion, located retromammary on MLO projection of the right breast, that is better visualized on tomosynthesis (B) than on 2D mammography (A). The lesion structure and its margins as well as the breast skin thickness show enhanced clarity on tomosynthesis.

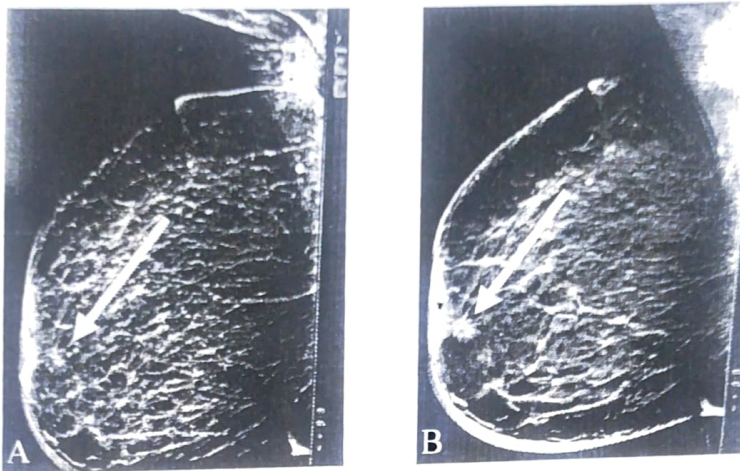


Figure 1. Comparison of breast cancer appearance: The left image (A) shows a suspicious lesion by standard 2D mammography while the right image (B) shows the same lesion with enhanced clarity by tomosynthesis.

Out of the 75 patients based on tomosynthesis, 55 were diagnosed with breast cancer, while 9 had benign findings based on histopathology. Based on the follow up, there were 4 patients with false negatives results and 7 patients with true negative results. Regarding the two modalities, the highest differences in true positive results and in false negative results were found. The diagnostic performance of each modality is summarized in Table 1.

Table 1. Diagnostic Performance of 2D Mammography and Tomosynthesis (n=75)

Metric	2D Mammography	3D Tomosynthesis
True positives (TP)	42	55
False positives (FP)	9	9
False negatives (FN)	16	4
True negatives (TN)	8	7
Sensitivity (%)	72.4	93.2*
Specificity (%)	47.1	43.8
Positive Predictive Value (%)	82.4	85.9
Negative Predictive Value (%)	33.3	63.6*

For 2D mammography, the sensitivity was 72.4% with a specificity of 47.1%. The PPV was 82.4% while the NPV was 33.3%. For tomosynthesis, sensitivity improved to 93.2% ($p < 0.5$), while specificity slightly decreased to 43.8%. The PPV was 85.9%, and the NPV increased substantially to 63.6%. Both modalities had similar false positive rates (9 each), but tomosynthesis demonstrated superior performance in identifying true positive cases (55 vs. 42) and reducing false negatives (4 vs. 16) compared to 2D mammography. The statistical significance for comparison between the two modalities was considered for both metrics, sensitivity and NPV (Table 1, Figure 2).

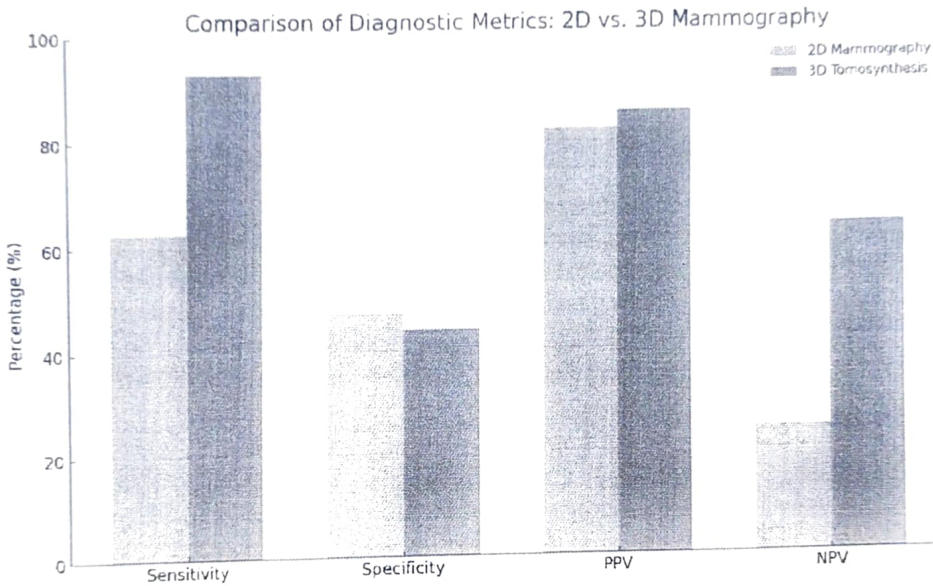


Figure 2. Comparison between 2D mammography and tomosynthesis across the 4 diagnostic performance metrics: sensitivity, specificity, PPV, NPV.

Discussion

This study compared the diagnostic performance of 2D mammography and tomosynthesis in a symptomatic population and demonstrated that tomosynthesis offers superior sensitivity and NPV compared to conventional 2D mammography (14). These findings are particularly important in clinical settings where patients present with breast symptoms and accurate triage is critical. The sensitivity of tomosynthesis was 93.2% outperforming the 72.4% observed with 2D mammography. This suggests that tomosynthesis is more effective at detecting malignant lesions, likely due to its ability to reduce the confounding effect of overlapping breast tissue. Importantly, the false negative rate was substantially lower for tomosynthesis compared to 2D mammography, emphasizing the clinical value of 3D in reducing missed diagnoses. Although specificity was relatively low for both modalities, this is probably not unexpected in a high prevalence diagnostic population. Both modalities yielded the same number of false positives, suggesting that the higher sensitivity of tomosynthesis did not come at the expense of increased false alarms. However, in this symptomatic cohort, both 2D and 3D imaging show very high sensitivity, because breast cancers are more likely, more visible, and radiologists are extra careful. The most notable difference between modalities was the NPV. This has major implications in clinical decision making, as a higher NPV increases confidence in excluding

malignancy when imaging is negative. This finding reinforces the potential of tomosynthesis as a valuable first line tool in diagnostic workup of patients with breast complaints. Our findings align with prior studies that report improved diagnostic accuracy with tomosynthesis, especially in dense breasts and symptomatic population (4, 8, 15, 16, 20, 22). However, most existing data stem from screening cohorts (3, 7, 9, 11, 16, 17). By focusing on symptomatic patients, our study fills an important gap and reflects real world diagnostic practice. Limitations of this study include the relatively small sample size and its retrospective design. Additionally, we did not stratify by breast density or lesion type, which could influence diagnostic accuracy. Nonetheless, all patients underwent both imaging modalities and were followed with histopathological confirmation, strengthening the reliability of our imaging comparison.

In the diagnostic study of women presenting with clinical breast symptoms, tomosynthesis demonstrated superior diagnostic performance compared to conventional 2D mammography. Specifically, tomosynthesis achieved higher sensitivity and significantly improved negative predictive value, while maintaining comparable specificity and positive predictive value. These findings support the integration of tomosynthesis into the diagnostic workflow for symptomatic patients, where accurate identification and exclusion of malignancy are critical. Further studies with larger populations and stratifications by breast density are required, in order to confirm the clinical advantages of 3D imaging in the evaluation of breast disease.

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