Cancer Management and Research

Dovepress

open access to scientific and medical research

Open Access Full Text Article

ORIGINAL RESEARCH

Value of Molybdenum Target X-Ray and High-Frequency Color Doppler Flow Imaging in Early Diagnosis of Breast Carcinoma: A Comparative Analysis

Xia Li, Shuang Xu, Liu-Wei Hao, Xiao-Ning Zhou

Health Management Discipline of Henan Provincial People's Hospital, Zhengzhou, Henan Province, 450000, People's Republic of China

Correspondence: Xia Li, Health Management Discipline of Henan Provincial People's Hospital, Zhengzhou, Henan Province, 450000, People's Republic of China, Tel +86 0371-65580070, Email 13213034900@163.com

Background: Breast carcinoma (BC) threatens the physical and mental health of women worldwide, and early diagnosis is important for improving patient outcomes and ensuring successful treatment.

Purpose: This research mainly aims to compare and analyze the value of molybdenum target X-ray and high-frequency color Doppler flow imaging (CDFI) in the early diagnosis of BC.

Methods: First, 102 patients with suspected early-stage BC (ESBC) admitted to Henan Provincial People's Hospital were examined by molybdenum target X-ray and CDFI. Based on the pathological findings, the diagnostic efficiency data of the two diagnostic modalities such as positive detection rate (PDR), positive predictive value (PPV), negative predictive value (NPV), sensitivity (SEN), specificity (SPE), and accuracy (ACC), as well as imaging information like masses, microcalcifications (MCs), axillary lymph node (LN) metastases, and blood flow signal or vascular sign abnormalities were analyzed.

Results: CDFI contributed to higher PDR, PRV, NPV, SEN, and ACC than molybdenum target X-ray in ESBC diagnosis, but similar SPE. The combined diagnosis of molybdenum target X-ray plus CDFI contributed to even higher PDR, PRV, NPV, SEN, and ACC than molybdenum target X-ray alone and higher ACC than CDFI. Imaging inspection revealed that the number of cases of masses, axillary LN metastases, and abnormalities in blood flow signals or vascular signs detected by CDFI was significantly higher than that by molybdenum target X-ray, while the number of MCs was significantly lower.

Conclusion: Molybdenum target X-ray plus CDFI is more effective in the diagnosis of ESBC and plays a complementary role in imaging examination, which can synergistically improve the diagnostic ACC of ESBC and is worthy of clinical promotion.

Keywords: molybdenum target X-ray, high-frequency color Doppler flow imaging, breast carcinoma, early diagnosis

Introduction

Breast carcinoma (BC), a common heterogeneous tumor that threatens women's physical and mental health all over the world, is influenced by age, obesity, smoking, alcohol consumption, family history, and use of oral contraceptives.[1–3] Worldwide, there are approximately 2.1 million females diagnosed as BC each year and 630,000 associated deaths.[4] Early diagnosis of BC, of no doubt, is conducive to improving survival outcomes and the probability of successful treatment in such patients.[5] Moreover, early monitoring is of great value in understanding BC progression and predicting the treatment response, allowing for effective and timely adjustment of treatment.[5–7] Thus, exploring the early diagnosis of BC is beneficial to reduce mortality in BC patients and improve the chance of survival.

Molybdenum target X-ray is an imaging technique that uses molybdenum target X-ray machine to take pictures of the patient's breast in oblique and axial planes, which can obtain information about the shape, margin, density, calcification and axillary lymph nodes (LNs) of the patient's breast mass.[8] This examination technique has the advantages of non-invasiveness and high resolution, with important guiding value in early diagnosis and prognosis evaluation of BC.[9] But it

Received: 10 April 2023
Accepted: 21 September 2023
Published: 16 October 2023

also has some shortcomings such as poor penetrability and difficulty in distinguishing deep and high lesions, which limits its diagnostic accuracy (ACC) in breast lesions and pathological properties.[10,11] High-frequency color Doppler flow imaging (CDFI) is another imaging inspection system that collects information such as the location, size, relationship with surrounding tissues and blood flow of the lesions by examining the lesions in different planes of the breast, which can effectively determine the nature of the lesions and distinguish the benign and malignant breast tumors.[12,13] This technique can also be applied to assess the response of tumor xenografts in nude mice to early antiangiogenic therapy.[14] Its drawbacks lie in the difficulty in distinguishing small lesions with unclear echoes and microcalcifications (MCs), as well as the difficulty in screening for ductal carcinoma in situ.[15] Molybdenum target X-ray has good diagnostic ability for early lesion morphology and microcalcification foci of BC, which can just make up for the shortcomings of CDFI.[16] Therefore, we believe that the combination of the two may have a synergistic effect on the early diagnosis of BC.

At present, the clinical application of molybdenum target X-ray plus CDFI in early diagnosis of BC is rarely reported. We speculate that the two approaches can synergistically improve the diagnosis efficiency in early diagnosis of BC, so we conduct relevant research and report it as follows.

Patients and Methods

Baseline Data

One hundred and two cases of suspected early-stage BC (ESBC) examined by molybdenum target X-ray and CDFI and treated in the Henan Provincial People's Hospital were selected. Patients' general data (age, course of disease, tumor diameter, etc.) can be found in Table 1. This retrospective study was approved by the Medical Research Ethics Committee of Henan Provincial People's Hospital. This study was conducted in accordance with the Declaration of Helsinki. As this study is a retrospective study, the data are anonymous and informed consent is not required.

Criteria for Patient Enrollment and Exclusion

Inclusion criteria: female patients with unilateral disease; palpable breast mass that appeared for the first time, with the presence of symptoms such as nipple inversion, galactorrhea, and breast pain; patients with calcification; voluntary inspection by molybdenum target X-ray and CDFI; complete clinical data and no deliberate concealment of clinical history.

Exclusion criteria: pregnant or lactating women; other malignancies; presence of pleural effusion as indicated by the imaging examination; heart, lung, kidney dysfunction or immune deficiency; contraindications for molybdenum target X-ray and CDFI examinations.

Inspection Methods

All patients were examined by molybdenum target X-ray and CDFI, using the methods described below.

(1) Molybdenum target X-ray inspection: Before the examination, the medical staff explained the relevant principles of the inspection and the precautions in the examination process, so as to improve patients' compliance with medical examinations. A full-field digital mammography system with a flat panel detector was used for inspection. X-ray photographs of both breasts were taken in the oblique and axial planes, and local compression and amplification or

Table 1 General Information

Patient Data	n=102
Age (years)	48.44±10.18
Course of disease (months)	3.63±0.58
Tumor diameter	2.83±0.48
Lesion site	
Left	62 (60.78%)
Right	40 (39.22%)

tangential photographs were taken if necessary to record the shape and quantity of the lesions and their relationship with the surrounding tissues.

(2) CDFI (AlokaProsound Alpha7, linear probe): The patient was placed in a supine position with arms raised and breasts and armpits fully exposed. Using a superficial probe with a frequency adjusted to 5.0–13.0 MHz, examinations in the longitudinal, transverse, and multi-sectional directions were performed on different quadrants of the breast with the nipple as the center, and the size, position, morphology, aspect ratio, and internal echo of the breast mass were observed. The CDFI images were then observed, including the presence or absence of blood flow in and around the lesion and the blood flow morphology. Blood flow classification was carried out by referring to the Adler semi-quantitative method.

Molybdenum target X-ray and CDFI were performed by two clinically experienced operators, and the inspection results were jointly reviewed by two experienced radiologists, neither of whom was aware of the purpose of the study and other variables. For details, please refer to Figures 1 and 2 for the molybdenum target X-ray and CDFI examination of two patients tested positive for B.

Detection Indicators

(1) Taking pathological examination as the gold standard, the positive detection rate (PDR), positive predictive value (PPV), negative predictive value (NPV), sensitivity (SEN), specificity (SPE), and ACC of molybdenum target X-ray and CDFI in differentiating suspected ESBC patients were compared and analyzed.

(2) CDFI and molybdenum target X-ray imaging features, mainly including masses, MCs, axillary LN metastases, and abnormalities in blood flow signals or vascular signs, were compared.

Statistical Analysis

In this study, SPSS 21.0 was used for data analysis. The mean±SEM was used to describe continuous variables, and the *t*-test was used for inter-group comparisons. Categorical variables, indicated by the ratios (percentages), were compared between groups by the χ^2 test. Statistical significance was declared if the P value was < 0.05.

Results

Patient Data

The average age of the patients with suspected ESBC was (48.44±10.18) years, the course of disease was (3.63±0.58) months, and the tumor diameter was (2.83±0.48) cm; the lesion was found on the left side in 62 (60.78%) and the right side in 40 cases (39.22%). The details are given in Table 1.

Molybdenum Target X-Ray Examination results

Using pathological findings as the gold standard, we collected data related to molybdenum target X-ray diagnosis of ESBC. The PDR, PPV, NPV, SEN, SPE, and ACC of molybdenum target X-ray in diagnosing ESBC were found to be 25.49%, 65.00%, 41.94%, 41.94%, 65.00%, and 50.98%, respectively (Table 2).

CDFI Inspection Results

Similarly, we statistically analyzed the relevant data of CDFI in the diagnosis of ESBC with pathological findings as the gold standard. Through further calculation, we found that the PDR, PPV, NPV, SEN, SPE, and ACC of CDFI in the diagnosis of ESBC were 47.06%, 87.27%, 70.21%, 77.42%, 82.50%, and 79.41, respectively (Table 3).

Combined Inspection Results of Molybdenum Target X-Ray Plus CDFI

Data analysis of molybdenum target X-ray + CDFI in the diagnosis of ESBC showed that the PDR, PPV, NPV, SEN, SPE, and ACC of the joint diagnosis were 53.92%, 94.83%, 84.09%, 88.71%, 92.50%, and 90.20%, respectively (Table 4).

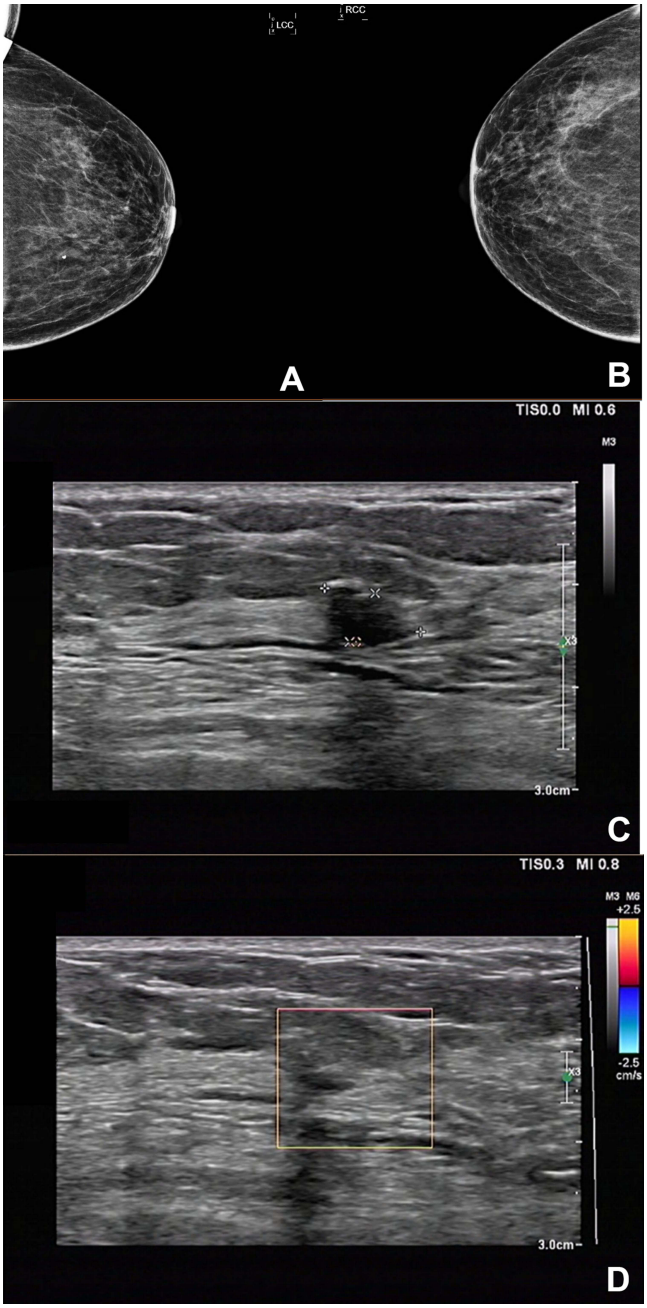

Figure 1 Results of a patient tested positive for breast carcinoma. (**A** and **B**). Molybdenum target X-ray results. (**C** and **D**). High-frequency color Doppler flow imaging (CDFI) results.

Diagnostic Value Analysis of Molybdenum Target X-Ray and CDFI

The diagnostic value of molybdenum target X-ray and CDFI in ESBC, either alone or in combination, was comparatively analyzed. CDFI was found to have higher PDR, PPV, NPV, SEN, and ACC ($P<0.05$) and comparable SPE ($P<0.01$) than molybdenum target X-ray. While molybdenum target X-ray + CDFI contributed to markedly higher indexes mentioned above than molybdenum target X-ray ($P<0.01$), and higher ACC than CDFI ($P<0.001$), as shown in Table 5.

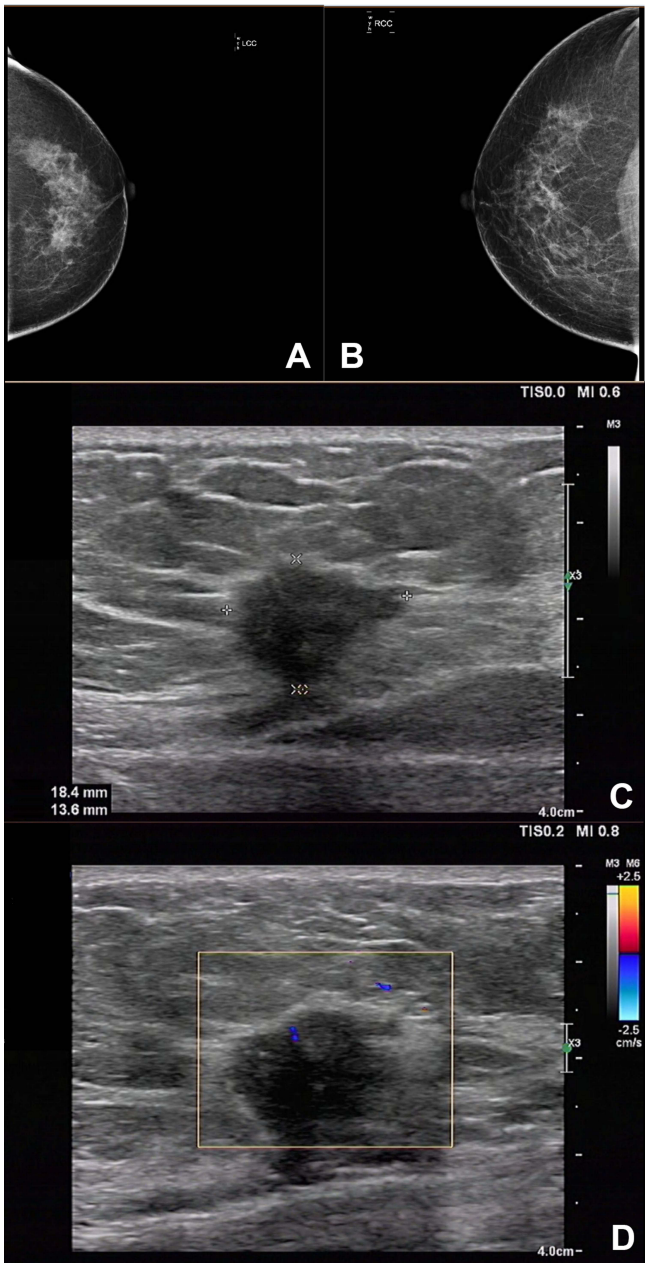

Figure 2 Results of another patient tested positive for breast carcinoma. (**A** and **B**). Molybdenum target X-ray results. (**C** and **D**). High-frequency color Doppler flow imaging (CDFI) results.

Imaging Results of Molybdenum Target X-Ray and CDFI

The imaging results of masses, MCs, axillary LN metastases, and abnormalities in blood flow signals or vascular signs were statistically analyzed. CDFI was significantly superior to molybdenum target X-ray in distinguishing tumor, axillary

Table 2 Molybdenum Target X-Ray Inspection Results

Molybdenum target X-ray	Pathologically positive	Pathologically negative	Total
Positive	26	14	40
Negative	36	26	62
Total	62	40	102

Table 3 CDFI Inspection Results

CDFI	Pathologically positive	Pathologically negative	Total
Positive	48	7	55
Negative	14	33	47
Total	62	40	102

Table 4 Results of the Joint Inspection by Molybdenum Target X-Ray Plus CDFI

Molybdenum target X-ray+CDFI	Pathologically positive	Pathologically negative	Total
Positive	55	3	58
Negative	7	37	44
Total	62	40	102

Table 5 Diagnostic Data of Molybdenum Target X-Ray and CDFI (%)

Methods	Positive detection rate	Positive predictive value	Negative predictive value	Sensitivity	Specificity	Accuracy
Molybdenum target X-ray	25.49 (26/102)	65.00 (26/40)	41.94 (26/62)	41.94 (26/62)	65.00 (26/40)	50.98 (52/102)
CDFI	47.06** (48/102)	87.27** (48/55)	70.21** (33/47)	77.42*** (48/62)	82.50 (33/40)	79.41*** (81/102)
Molybdenum target X-ray+CDFI	53.92*** (55/102)	94.83*** (55/58)	84.09*** (37/44)	88.71*** (55/62)	92.50** (37/40)	90.20***# (92/102)

Notes: **P<0.01 and ***P<0.001 vs molybdenum target X-ray; #P<0.05 vs CDFI.

Table 6 Imaging Results of Molybdenum Target X-Ray and CDFI

Methods	Mass	Microcalcification	Axillary lymph node metastasis	Blood flow signal or vascular sign abnormalities
Molybdenum target X-ray	70 (68.63)	66 (64.71)	20 (19.61)	36 (35.29)
CDFI	92 (90.20)	31 (30.39)	41 (40.20)	56 (54.90)
χ^2	14.512	24.078	10.313	7.919
P	<0.001	<0.001	0.001	0.005

LN metastases, and blood flow signal or vascular sign abnormalities (P<0.05), while molybdenum target X-ray had markedly better performance in identifying MCs than CDFI (P<0.05), as shown in Table 6.

Discussion

Early diagnosis of BC has been shown to improve patient survival by up to 20%.[17] Most BC patients present with advanced disease at diagnosis, which is associated with a high risk of metastasis and recurrence even after tumor resection.[18] Although pathological testing is the golden standard for determining BC staging, this test is lowly accepted by some patients.[19] Therefore, an effective, reliable and highly accepted screening technique for ESBC is particularly needed to help BC patients improve their survival outcomes.

Molybdenum target X-ray, CDFI, and magnetic resonance imaging (MRI) are commonly used imaging techniques for the early diagnosis of BC, which is conducive to improving ESBC screening efficiency.[20] Of them, MRI is not suitable for early BC screening due to its disadvantages such as high cost, complicated procedure, and overdiagnosis.[21] A great number of studies have explored the application of molybdenum target X-ray and CDFI in diagnosing BC. Tailaiti

G et al,[9] for example, found that the molybdenum target X-ray features of invasive BC are related to immune indexes such as estrogen receptor, progesterone receptor, and human epidermal growth factor receptor 2, which can reflect pathological information like nipple depression, axillary LN enlargement and maximum tumor diameter. Hu et al[22] pointed out that molybdenum target X-ray combined with dynamic contrast-enhanced MRI can improve the diagnostic efficiency of BC of different molecular types (Luminal-A/B, HER2-positive, and triple negative BC) compared with their single use. In addition, the response of BC patients to chemotherapy can be evaluated by using the resistivity index, pulsatility index, and maximum flow rate of CDFI, facilitating the prediction of the efficacy of treatment schemes and the clinical outcomes of patients.[23] Rjosk-Dendorfer et al[24] also reported that CDFI plus high-resolution compression elastography can improve the diagnostic ACC of benign and malignant breast masses. Li et al[25] proposed that CDFI combined with strain elastography can enhance the screening efficiency of B-ultrasound for benign and malignant non-mass breast lesions. In our research, CDFI and CDFI + molybdenum target X-ray showed markedly higher PDR (47.06%, 53.92% vs 25.49%), PPV (87.27%, 94.83% vs 65.00%), and NPV (70.21%, 84.09% vs 41.94%) than molybdenum target X-ray alone. Furthermore, the SEN (88.71% vs 41.94%), SPE (92.50% vs 65.00%), and ACC (90.20% vs 50.98%) of the joint examination were notably higher compared with molybdenum target X-ray, and the ACC (90.20% vs 79.41%) was also obviously higher compared to CDFI. Two conclusions can be drawn from the above data. First, the combined examination by molybdenum target X-ray and CDFI can significantly improve the diagnostic ACC (compared with any single examination) in the 102 patients with suspected ESBC, with significant superiority over molybdenum target X-ray in other indicators such as PDR, PPV, NPV, SEN, and SPE. Second, the above diagnostic data of CDFI, except for SPE, are significantly better than those of molybdenum target X-ray. The frequency of CDFI used in this study ranges from 5.0MHz to 13.0MHz, with relatively high spatial resolution, which helps to display anomalies from the superficial to the deep plane of the breast while providing better image quality.[26] In addition, the superiority of CDFI may lie in its ability to present clear anatomical layers of the lesion through acoustic impedance differences, thus helping to determine the elasticity and activity of the lesion. Moreover, CDFI is less affected by external interference and gland density, which is conducive to reducing the missed diagnosis rate. The higher diagnostic ACC of the combination of the two methods may be related to their synergistic improvement in the early diagnosis of BC. Breast masses, axillary LN metastases, abnormal blood flow signals or vascular signs, and MCs are common symptoms in women with BC and are helpful in identifying breast malignancies.[27] In imaging examinations in this study, CDFI screened significantly more cases of masses, axillary LN metastases, and blood flow signal or vascular sign abnormalities than molybdenum target X-ray, while molybdenum target X-ray detected significantly greater number of cases of MCs than CDFI, suggesting that the two can complement each other in screening early pathological features of BC. Evidence has shown that CDFI can show information such as subcutaneous mammary gland, internal fine structure of each layer, tumor margins and internal echo characteristics, while revealing the blood flow and axillary LNs in the breast tumor to help identify the nature of the tumor. However, the image of micro-calcified foci displayed by CDFI is a spot-like strong echo with no distinct features, which may explain the inferior diagnostic advantage of CDFI in micro-calcified foci over molybdenum target X-ray.

This study has several limitations that need to be carefully considered and refined. First, this study is a small sample analysis and the sampling range is not samples without specific clinical suspicion, which may affect the accuracy of the research results to some extent. Second, as a single-center study, there may be information collection bias. Third, mammography or ultrasonic elastography was not included in the comparative analysis, and the findings would be more comprehensive if the analysis data in this aspect could be supplemented. In the future, this study will be gradually improved based on the above aspects, such as expanding the sample size and sampling range and supplementing mammography-related data.

Conclusion

CDFI significantly outperforms molybdenum target X-ray for early diagnosis of BC. The combination of the two can significantly improve diagnostic ACC for ESBC and provide more comprehensive clinical information for early diagnosis of BC.

Funding

This Study Did Not Receive Any Funding in Any Form.

Disclosure

The authors declare no competing interests in this work.

References

1. Rashed A, Fitzpatrick OM, Easty DJ, et al. An observational study of dose dense chemotherapy with lipegfilgrastim support in early breast cancer. *BMC Cancer*. 2023;23(1):171. PMID: 36803350. doi:10.1186/s12885-023-10603-0
2. Barzaman K, Karami J, Zarei Z, et al. Breast cancer: biology, biomarkers, and treatments. *Int Immunopharmacol*. 2020;84:106535. PMID: 32361569. doi:10.1016/j.intimp.2020.106535
3. Fakhri N, Chad MA, Lahkim M, et al. Risk factors for breast cancer in women: an update review. *Med Oncol*. 2022;39(12):197. PMID: 36071255. doi:10.1007/s12032-022-01804-x
4. Rahman SA, Al-Marzouki A, Otim M, Khalil Khayat NEH, Yousuf R, Rahman P. Awareness about breast cancer and breast self-examination among female students at the University of Sharjah: a cross-sectional study. *Asian Pac J Cancer Prev*. 2019;20(6):1901–1908. PMID: 31244316; PMCID: PMC7021607. doi:10.31557/APJCP.2019.20.6.1901
5. Li X, Zou W, Wang Y, et al. Plasma-based microRNA signatures in early diagnosis of breast cancer. *Mol Genet Genomic Med*. 2020;8(5):e1092. PMID: 32124558; PMCID: PMC7216817. doi:10.1002/mgg3.1092
6. Tagliafico AS, Piana M, Schenone D, Lai R, Massone AM, Houssami N. Overview of radiomics in breast cancer diagnosis and prognostication. *Breast*. 2020;49:74–80. PMID: 31739125; PMCID: PMC7375670. doi:10.1016/j.breast.2019.10.018
7. Jiang M, Li CL, Luo XM, et al. Ultrasound-based deep learning radiomics in the assessment of pathological complete response to neoadjuvant chemotherapy in locally advanced breast cancer. *Eur J Cancer*. 2021;147:95–105. PMID: 33639324. doi:10.1016/j.ejca.2021.01.028
8. Yiming A, Wubulikasimu M, Yusuying N. Analysis on factors behind sentinel lymph node metastasis in breast cancer by color ultrasonography, molybdenum target, and pathological detection. *World J Surg Oncol*. 2022;20(1):72. PMID: 35255911; PMCID: PMC8902784. doi:10.1186/s12957-022-02531-3
9. Tailaiti G, Maimaiti G, Aikeremu Y, Tuerdi B. Molybdenum target x-ray features and estrogen receptor, progesterone receptor, and human epidermal growth factor receptor 2 in invasive breast cancer. *Int J Gen Med*. 2021;14:2777–2783. PMID: 34188531; PMCID: PMC8236255. doi:10.2147/IJGM.S314055
10. Gu WQ, Cai SM, Liu WD, Zhang Q, Shi Y, Du LJ. Combined molybdenum target X-ray and magnetic resonance imaging examinations improve breast cancer diagnostic efficacy. *World J Clin Cases*. 2022;10(2):485–491. PMID: 35097073; PMCID: PMC8771396. doi:10.12998/wjcc.v10.i2.485
11. He H, Zhang G, Zhou H, et al. Differential efficacy of b-ultrasound combined with molybdenum target detection mode for breast cancer staging and correlation of blood flow parameters with IGF-1 and IGF-2 expression level and prognosis. *Contrast Media Mol Imaging*. 2022;2022:9198626. PMID: 35845730; PMCID: PMC9249492. doi:10.1155/2022/9198626
12. Chae EY, Moon WK, Kim HH, et al. Association between ultrasound features and the 21-gene recurrence score assays in patients with oestrogen receptor-positive, HER2-negative, invasive breast cancer. *PLoS One*. 2016;11(6):e0158461. PMID: 27362843; PMCID: PMC4928814. doi:10.1371/journal.pone.0158461
13. Sun L, Qi M, Cui X, Song Q, Asghar M. The clinical application of combined ultrasound, mammography, and tumor markers in screening breast cancer among high-risk women. *Comput Math Methods Med*. 2022;2022:4074628. PMID: 35872933; PMCID: PMC9307376. doi:10.1155/2022/4074628
14. Jugold M, Palmowski M, Huppert J, et al. Volumetric high-frequency Doppler ultrasound enables the assessment of early antiangiogenic therapy effects on tumor xenografts in nude mice. *Eur Radiol*. 2008;18(4):753–758. PMID: 18084768. doi:10.1007/s00330-007-0825-5
15. Yoon JH, Kim MJ, Lee HS, et al. Validation of the fifth edition BI-RADS ultrasound lexicon with comparison of fourth and fifth edition diagnostic performance using video clips. *Ultrasonography*. 2016;35(4):318–326. PMID: 27184655; PMCID: PMC5040135. doi:10.14366/usg.16010
16. Su QH, Zhang Y, Shen B, Li YC, Tan J. Application of molybdenum target X-ray photography in imaging analysis of caudal intervertebral disc degeneration in rats. *World J Clin Cases*. 2020;8(16):3431–3439. PMID: 32913849; PMCID: PMC7457105. doi:10.12998/wjcc.v8.i16.3431
17. Zejda JE, Kaleta A. Modes of early detection of breast cancer in Katowice Region, Poland. *Int J Environ Res Public Health*. 2020;17(8):2642. PMID: 32290585; PMCID: PMC7215776. doi:10.3390/ijerph17082642
18. Chee W, Lee Y, Im EO, et al. A culturally tailored internet cancer support group for Asian American breast cancer survivors: a randomized controlled pilot intervention study. *J Telemed Telecare*. 2017;23(6):618–626. PMID: 27486198; PMCID: PMC6186171. doi:10.1177/1357633X16658369
19. Edenfield J, Schammel C, Collins J, Schammel D, Edenfield WJ. Metaplastic breast cancer: molecular typing and identification of potential targeted therapies at a single institution. *Clin Breast Cancer*. 2017;17(1):e1–e10. PMID: 27568101. doi:10.1016/j.clbc.2016.07.004
20. Morrow M, Waters J, Morris E. MRI for breast cancer screening, diagnosis, and treatment. *Lancet*. 2011;378(9805):1804–1811. PMID: 22098853. doi:10.1016/S0140-6736(11)61350-0
21. Wang L. Early diagnosis of breast cancer. *Sensors*. 2017;17(7):1572. PMID: 28678153; PMCID: PMC5539491. doi:10.3390/s17071572
22. Hu Y, Zhang Y, Cheng J. Diagnostic value of molybdenum target combined with DCE-MRI in different types of breast cancer. *Oncol Lett*. 2019;18(4):4056–4063. PMID: 31516606; PMCID: PMC6732951. doi:10.3892/ol.2019.10746
23. Kumar A, Srivastava V, Singh S, Shukla RC. Color Doppler ultrasonography for treatment response prediction and evaluation in breast cancer. *Future Oncol*. 2010;6(8):1265–1278. PMID: 20799873. doi:10.2217/fon.10.93
24. Rjosk-Dendorfer D, Gürtler VM, Sommer WH, Reiser M, Clevert DA. Value of high resolution compression elastography and color Doppler sonography in characterisation of breast lesions: comparison of different high-frequency transducers. *Clin Hemorheol Microcirc*. 2014;57(2):129–135. PMID: 24584321. doi:10.3233/CH-141824
25. Li L, Zhou X, Zhao X, et al. B-mode ultrasound combined with color Doppler and strain elastography in the diagnosis of non-mass breast lesions: a prospective study. *Ultrasound Med Biol*. 2017;43(11):2582–2590. PMID: 28844465. doi:10.1016/j.ultrasmedbio.2017.07.014

26. Corvino A, Varelli C, Catalano F, et al. Use of high-frequency transducers in breast sonography. *J Pers Med*. 2022;12(12):1960. PMID: 36556182; PMCID: PMC9786615. doi:10.3390/jpm12121960
27. Koo MM, von Wagner C, Abel GA, McPhail S, Rubin GP, Lyratzopoulos G. Typical and atypical presenting symptoms of breast cancer and their associations with diagnostic intervals: evidence from a national audit of cancer diagnosis. *Cancer Epidemiol*. 2017;48:140–146. PMID: 28549339; PMCID: PMC5482318. doi:10.1016/j.canep.2017.04.010