Acta Medica Young Doctors
ISSN: 3108-4532
Volume 2 Issue 4

Investigation of the Relationship Between Breast Arterial Calcifications and Mammographic Breast Density: Risk Assessment

Original Article

İsmail Parlak[1]

1. İzmir Bakırçay University, Çiğli Training and Research Hospital, Department of Radiology

ABSTRACT

Aim: To investigate the possible relationship between breast arterial calcifications (BAC) detected on mammograms and mammographic breast density, and indirectly, the association of BAC with breast cancer risk.

Materials and Methods: Data from 160 female patients who presented to the Radiology Clinic for screening and had suitable mammography images were retrospectively reviewed. Patient age, BI-RADS breast density category, and BAC data were recorded and statistically evaluated.

Results: The prevalence of BAC was found to be 48.8% (78/160). The mean age of BAC-positive patients was 62.9 ± 9.8 years, while that of BAC-negative patients was 53.5 ± 10.2 years ($p < 0.001$). According to the four-category BI-RADS classification, a borderline significant association ($p = 0.076$) was detected between the presence of BAC and breast density using the Pearson chi-square test, and a significant association was found with the Linear-by-Linear trend test ($p = 0.017$). However, in the binary classification commonly used in clinical practice (low: A+B, high: C+D), there was no significant difference in BAC prevalence between the groups ($p = 0.732$). In multivariate logistic regression analysis after age adjustment, breast density was not found to be an independent risk factor for the presence of BAC ($p > 0.05$).

Conclusion: Although a limited association was observed between the presence of BAC and breast density, no significant relationship was detected in the binary classification. It is considered that age is a much more dominant factor than breast density in the formation of BAC.

Keywords: Mammography, breast arterial calcification, BI-RADS

Introduction

Breast cancer is one of the leading causes of cancer-related deaths and is the most frequently diagnosed cancer among women worldwide. According to data from the World Health Organization (WHO) and GLOBOCAN 2020, more than 2.3 million women were diagnosed with breast cancer in 2020, accounting for 11.7% of all cancer cases [1, 2]. The American Cancer Society (ACS) states that early detection and treatment through screening methods represent one of the most effective approaches to reducing breast cancer mortality [3]. Given the critical role of early diagnosis, understanding the advantages and limitations of current screening methods is of great importance. Mammography is internationally

Corresponding: İsmail Parlak, İzmir Bakırçay University, Çiğli Training and Research Hospital, Department of Radiology, drismailparlak@gmail.com
Doi: 10.66288/actamedi.2026.146

recognized as a screening modality proven to reduce breast cancer mortality [4-8]. Nevertheless, in recent years, the potential of personalized, risk-based screening approaches has been increasingly investigated. It has been suggested that women with dense breast tissue on mammography may particularly benefit from such programs [9-11]. Dense breast tissue has been consistently associated with markedly reduced mammographic sensitivity and higher cancer rates [12-17]. The most widely used system for classifying breast density today is the 5th edition of the Breast Imaging Reporting and Data System (BI-RADS), developed in 2013. This system categorizes breast density into four levels: almost entirely fatty (A), scattered areas of fibroglandular density (B), heterogeneously dense (C), and extremely dense (D) [18-19]. Another finding commonly observed on mammograms is breast arterial calcification (BAC), which has traditionally not been considered a clinically active finding. However, recent studies have demonstrated that BAC correlates with angiographically defined coronary artery disease [20-23] and is associated with an increased risk of cardiovascular disease (CVD) [24-28]. These data indicate that breast density is associated with breast cancer risk, whereas BAC is linked to cardiovascular disease risk.

In this study, the potential relationship between the presence of breast arterial calcification (BAC) and mammographic breast density in women undergoing screening mammography was investigated, thereby examining whether BAC could serve as an indirect marker in breast cancer risk assessment. The potential association between these two findings may contribute to the development of risk assessment strategies and pave the way for innovative approaches in clinical practice.

Materials and Methods

This retrospective study was approved by the local ethics committee, and the requirement for informed consent was waived (18/06/2025, decision number: 2315, research number: 2315). The study included 160 patients who presented to the Radiology Clinic of our hospital between 2020 and 2025 for breast screening purposes and had suitable mammographic images. Patients younger than 18 years, pregnant patients, male patients, those with a history of breast cancer, those with a family history of breast cancer, those who had undergone breast surgery, and those with breast prostheses were excluded from the study.Patients' ages were recorded. Mammographic images were classified by a single physician according to BI-RADS criteria for breast parenchymal density and evaluated for the presence or absence of BAC. The obtained findings were recorded both on an examination basis and on a patient basis. Radiological findings were statistically analyzed according to patients' ages.

Statistical Analysis

Data analysis was performed using the SPSS version 26 statistical package. Pearson's chi-square test and Fisher's exact test were used for categorical variables, while the Mann-Whitney U test was employed for continuous variables. Trend analysis was conducted using the Linear-by-Linear Association test. Multivariate logistic regression analysis was applied to identify independent risk factors predicting the presence of BAC. A p-value < 0.05 was considered statistically significant.

Results

The demographic characteristics of the study population and the BI-RADS distribution are summarized in Table 1, while the distribution of BAC according to BI-RADS categories is presented in Table 2.

Corresponding: İsmail Parlak, İzmir Bakırçay University, Çiğli Training and Research Hospital, Department of Radiology, drismailparlak@gmail.com
Doi: 10.66288/actamedi.2026.146

The prevalence of BAC was 48.8% (78/160). Patients with BAC (+) were significantly older (62.9 ± 9.8 vs. 53.5 ± 10.2 years; $p < 0.001$) (Table 3).In the four-category BI-RADS assessment, the Pearson chi-square test yielded $p = 0.076$, whereas the Linear-by-Linear trend test was significant with $p = 0.017$, indicating a mild decreasing trend in BAC rates as density increased. However, in the binary classification (A+B vs. C+D), no significant difference was observed ($p = 0.732$).In multivariate logistic regression analysis incorporating age, only age remained an independent predictor of BAC presence (OR 1.095, 95% CI 1.058–1.134, $p < 0.001$); breast density categories were not independent risk factors (Table 4).

Table 1: General Characteristics of the Study Population and BIRADS Distribution (n = 160)

Characteristic	Value
Age (years), mean ± SD	57.9 ± 1.2
Age (years), median (min-max)	58 (40-70)
BAC positive	78 (%48.8)
BAC negative	82 (%51.2)
BI-RADS A	14 (%8.8)
BI-RADS B	74 (%46.2)
BI-RADS C	55 (%34.4)
BI-RADS D	17 (%10.6)

Table 2: Distribution of Breast Arterial Calcification (BAC) According to BI-RADS Categories

BI-RADS Category	BAC (+) n (%)	BAC (-) n (%)	Total
A	4 (28,6)	10 (71.4)	14
B	40 (54.1)	34 (45.9)	74
C	27 (49.1)	28 (50.9)	55
D	7 (41.2)	10 (58.8)	17
Total	78 (48.8)	82 (51.2)	160

Pearson Ki-kare =6.864, df = 3, p=0.076

Linear-byLinear Association = 5.748, p = 0.017

Corresponding: İsmail Parlak, İzmir Bakırçay University, Çiğli Training and Research Hospital, Department of Radiology, drismailparlak@gmail.com
Doi: 10.66288/actamedi.2026.146

Table 3: Age Comparison According to Breast Arterial Calcification (BAC) Status

BAC Status	n	Mean ± SD	Median (min-max)	Mann-Whitney U	p-value
BAC positive	78	62.9 ± 9.8	63 (40-70)	1372.5	< 0.001
BAC negative	82	53.5 ± 10.2	52 (40-70)		

Table 4: Multivariate Logistic Regression Analysis for the Presence of Breast Arterial Calcification (BAC) (Dependent variable: Presence of BAC)

Variable	OR	%95 CI	p-value
Age (per 1-year increase)	1.100	1.062 – 1.139	< 0.001
BI-RADS category (reference: A)			0.339*
BI-RADS B	1.74	0.51 – 5.94	0.378
BI-RADS C	1.70	0.48 – 6.06	0.411
BI-RADS D	1.37	0.33 – 5.76	0.665
High density (C+D vs A+B)	0.91	0.48 – 1.73	0.773

*Omnibus test p-value

Hosmer-Lemeshow goodness-of-fit: p = 0.789

Nagelkerke R^2= 0.257

Discussions

Breast cancer is the most common malignancy in women and holds a significant place among cancer-related deaths [1, 2]. Mammography is an effective screening method proven to reduce mortality [4-8]. In recent years, risk-based personalized screening approaches have gained increasing importance, and it has been suggested that women with dense breast tissue on mammography may particularly benefit from such programs [9-11]. Dense breast tissue has been associated with markedly reduced mammographic sensitivity and higher cancer rates [12-17]. Among the 160 patients included in our study, 55 were in BI-RADS category C and 17 in BI-RADS category D, totaling 72 patients identified as having dense breast parenchyma. Although breast arterial calcification (BAC), a frequently encountered finding on mammograms, has long been considered clinically insignificant, recent studies have demonstrated that BAC shows significant correlation with coronary artery disease and may increase the risk of cardiovascular disease (CVD). In the literature, the prevalence of BAC in screening populations ranges from 10% to 50% [20-28]; in our study, it was found to be 48.8%, which is consistent with the wide range reported in the literature, particularly considering the older patient group.

Age is the most well-known traditional risk factor for CVD [29]. In line with the

Corresponding: İsmail Parlak, İzmir Bakırçay University, Çiğli Training and Research Hospital, Department of Radiology, drismailparlak@gmail.com
Doi: 10.66288/actamedi.2026.146

literature, patients with BAC in our study were significantly older (62.9 ± 9.8 years vs. 53.5 ± 10.2 years; $p < 0.001$). The strongest association was observed with age, a finding replicated in numerous studies. When the presence of BAC and breast parenchymal density were evaluated in the patients included in our study, no statistically significant relationship was found between breast density and the presence of BAC. Furthermore, even after age adjustment, breast parenchymal density was not identified as an independent risk factor for the presence of BAC. Limitations of the study include the relatively small sample size, single-center and retrospective design, lack of evaluation of other cardiovascular risk factors (hypertension, diabetes, smoking, etc.), and assessment of images by a single reader.

Conclusion

Mammography is highly beneficial in breast cancer screening. Nevertheless, in recent years, the potential of personalized, risk-based screening approaches has been increasingly investigated. It has been suggested that women with dense breast tissue on mammography may particularly benefit from such programs. In our study, no statistically significant relationship was found between breast parenchymal density and BAC. The presence of BAC was primarily associated with advanced age and cannot be used as an independent parameter in breast cancer risk assessment. In future studies, this relationship could be re-evaluated with larger sample sizes and the inclusion of additional risk factors.

Acknowledge

Cite: Parlak, İ. (2026). Investigation of the Relationship Between Breast Arterial Calcifications and Mammographic Breast Density: Risk Assessment. Acta Medica Young Doctors, 2(4), 141–147.

References

1. World Health Organization. Breast Cancer. 2021. Available online: https://www.who.int/news-room/fact-sheets/detail/breast-cancer (accessed on 1 April 2023).

2. Sung, H.; Ferlay, J.; Siegel, R.L.; Laversanne, M.; Soerjomataram, I.; Jemal, A.; Bray, F. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J. Clin. 2021, 71, 209–249. [Google Scholar] [CrossRef] [PubMed]

3. American Cancer Society [homepage on the Internet]. American cancer society recommendations for the early detection of breast cancer. Atlanta: American Cancer Society; 2023. Available from: https://www.cancer.org/cancer/types/breast-cancer/screening-tests- and-early-detection/american-cancer-society-recommendations-for-the- early-detection-of-breast-cancer.html(open in a new window). Accessed October 5, 2024.

4. Kwon MR, Chang Y, Park B, Ryu S, Kook SH. Performance analysis ofscreening mammography in Asian women under 40 years. Breast Cancer.2023;30(2):241–248. doi:10.1007/s12282-022-01414-5

5. Tabár L, Yen AMF, Wu WYY, et al. Insights from the breast cancer screening trials: how screening affects the natural history of breast cancer and implications for evaluating service screening programs. Breast J. 2015;21(1):13–20. doi:10.1111/tbj.12354

6. Ozmen V, Gurdal SO, Cabioglu N, et al. Cost-effectiveness of breast cancer screening in turkey, a developing country: results from bahçeşehir mammography screening project. Eur J Breast Health.

Corresponding: İsmail Parlak, İzmir Bakırçay University, Çiğli Training and Research Hospital, Department of Radiology, drismailparlak@gmail.com
Doi: 10.66288/actamedi.2026.146

2017;13(3):117–122.
doi:10.5152/ejbh.2017.3528

7. Hussein H, Abbas E, Keshavarzi S, et al. Supplemental breast cancer screening in women with dense breasts and negative mammography: a systematic review and meta-analysis. Radiology. 2023;306(3):e221785. doi:10.1148/radiol.221785

8. Zeeshan M, Salam B, Khalid QSB, Alam S, Sayani R. Diagnostic accuracy of digital mammography in the detection of breast cancer. Cureus. 2018. doi:10.7759/cureus.2448

9. Harkness, E.F. · Astley, S.M. · Evans, D.G. Risk-based breast cancer screening strategies in women Best Pract Res Clin Obstet Gynaecol. 2020 May 1; 65:3-17

10. Bakker, M.F. · De Lange, S.V. · Pijnappel, R.M. ... Supplemental MRI screening for women with extremely dense breast tissue N Engl J Med. 2019; 381:2091-2102

11. Mann, R.M. · Athanasiou, A. · Baltzer, P.A.T. ... Breast cancer screening in women with extremely dense breasts recommendations of the European Society of Breast Imaging (EUSOBI) Eur Radiol. 2022 Mar 8; 32:4036-4045

12. Boyd, N.F. · Guo, H. · Martin, L.J. ... Mammographic density and the risk and detection of breast cancer N Engl J Med. 2007; 356:227-236

13. de Munck, L. · Siesling, S. · Fracheboud, J. ... Impact of mammographic screening and advanced cancer definition on the percentage of advanced-stage cancers in a steady-state breast screening programme in The Netherlands Br J Cancer. 2020 Sep 29; 123:1191-1197

14. Wanders, J.O.P. · Holland, K. · Veldhuis, W.B. ... Volumetric breast density affects performance of digital screening mammography Breast Cancer Res Treat. 2017; 162:95-103

15. Boyd, N.F. · Lockwood, G.A. · Byng, J.W. ... Mammographic densities and breast cancer risk Cancer Epidemiol Biomarkers Prev. 1998; 7:1133-1144

16. Kerlikowske, K. The mammogram that cried wolfe N Engl J Med. 2007; 356:297-300

17. Mandelson, M.T. · Oestreicher, N. · Porter, P.L. ... Breast density as a predictor of mammographic detection: comparison of interval- and screen-detected cancers J Natl Cancer Inst. 2000; 92:1081-1087

18. McCormack, V.A. · Dos Santos Silva, I. Breast density and parenchymal patterns as markers of breast cancer risk: a meta-analysis Cancer Epidemiol Biomarkers Prev. 2006; 15:1159-1169

19. D'Orsi, C.J. · Sickles, E.A. · Mendelson, E.B.M.E. ACR BI-RADS® atlas, breast imaging reporting and data system American College of Radiology, Reston, VA, 2013

20. Kelly BS, ScanlON E, Heneghan H, Redmond CE, Healy GM, Mc Dermott E, Heffernan EJ, Prichard R, Mc Nally S. Breast arterial calcification on screening mammography can predict significant coronary artery disease in women. Clin Imaging. 2018;49:48–53. doi: 10.1016/j.clinimag.2017.10.021

21. Mostafavi L, Marfori W, Arellano C, Tognolini A, Speier W, Adibi A, Ruehm SG. Prevalence of coronary artery disease evaluated by coronary CT angiography in women with mammographically detected breast arterial calcifications. PLoS One. 2015;10:e0122289. doi: 10.1371/journal.pone.0122289

22. Newallo D, Meinel FG, Schoepf UJ, Baumann S, De Cecco CN, Leddy RJ,

Corresponding: İsmail Parlak, İzmir Bakırçay University, Çiğli Training and Research Hospital, Department of Radiology, drismailparlak@gmail.com
Doi: 10.66288/actamedi.2026.146

Vliegenthart R, Möllmann H, Hamm CW, Morris PB, et al. Mammographic detection of breast arterial calcification as an independent predictor of coronary atherosclerotic disease in a single ethnic cohort of African American women. Atherosclerosis. 2015;242:218–221. doi: 10.1016/j.atherosclerosis.2015.07.004

23. Ružičić D, Dobrić M, Vuković M, Hrnčić D, Đorđević S, Ružičić M, Aleksandrić S, Đorđević- Dikić A, Beleslin B. The correlation of SYNTAX score by coronary angiography with breast arterial calcification by digital mammography. Clin Radiol. 2018;73:454–459. doi: 10.1016/j.crad.2017.12.002

24. Ferreira JA, Pompei LM, Fernandes CE, Azevedo LH, Peixoto S. Breast arterial calcification is a predictive factor of cardiovascular disease in Brazilian postmenopausal women. Climacteric. 2009;12:439–444. doi: 10.1080/13697130902957287

25. Iribarren C, Go AS, Tolstykh I, Sidney S, Johnston SC, Spring DB. Breast vascular calcification and risk of coronary heart disease, stroke, and heart failure. J Womens Health (Larchmt). 2004;13:381–9; discussion 390. doi: 10.1089/154099904323087060

26. Kataoka M, Warren R, Luben R, Camus J, Denton E, Sala E, Day N, Khaw KT. How predictive is breast arterial calcification of cardiovascular disease and risk factors when found at screening mammography? AJR Am J Roentgenol. 2006;187:73–80. doi: 10.2214/AJR.05.0365

27. Kemmeren JM, van Noord PA, Beijerinck D, Fracheboud J, Banga JD, van der Graaf Y. Arterial calcification found on breast cancer screening mammograms and cardiovascular mortality in women: the DOM Project. Doorlopend Onderzoek Morbiditeit en Mortaliteit. Am J Epidemiol. 1998;147:333–341. doi: 10.1093/oxfordjournals.aje.a009455

28. Schnatz PF, Marakovits KA, O'Sullivan DM. The association of breast arterial calcification and coronary heart disease. Obstet Gynecol. 2011;117(2 Pt 1):233–241. doi: 10.1097/AOG.0b013e318206c8cb

29. Age As a Risk Factor Dhingra, Ravi et al. Medical Clinics, Volume 96, Issue 1, 87-91.

Corresponding: İsmail Parlak, İzmir Bakırçay University, Çiğli Training and Research Hospital, Department of Radiology, drismailparlak@gmail.com
Doi: 10.66288/actamedi.2026.146