DOI: 10.7860/JCDR/2023/63071.18450

Original Article

Radiology Section

Breast Arterial Calcification in Screening Mammograms and its Correlation with Carotid Intima Media Thickness: A Cross-sectional Study

ALEENA KHAN[1], VARUN NARAYAN[2], HAREESH JAYARAM[3], MANOJ KRISHNA SAJEEV[4], ROBERT P AMBOOKEN[5]

ABSTRACT

Introduction: Atherosclerosis is a leading cause of cardiovascular mortality worldwide. According to American Cancer Society (ACS) guidelines, screening mammography is optional for all women above the age of 40 years to detect breast cancer early. Incidentally, Breast Arterial Calcification (BAC) can be observed in mammograms. Women with BAC and additional risk factors like diabetes or hypertension may be referred for cardiovascular risk assessment in the future if there is a significant correlation between Carotid Intima Media Thickness (CIMT) and BAC.

Aim: To assess BAC among women undergoing screening mammography and determine the correlation between BAC and CIMT.

Materials and Methods: A cross-sectional study was conducted on 152 women who underwent screening mammography in the Department of Radiodiagnosis, Amala Institute of Medical Sciences, Thrissur, Kerala, India from May 2021 to October 2022. The presence and grading of BAC were determined using the Seimens Mammomat 1000 mammography unit, which captured two standard views: the Mediolateral Oblique (MLO) and Craniocaudal (CC) views. CIMT was measured using B-mode ultrasonography with an 8-13 MHz linear transducer, taking measurements from two contiguous sites at 1 cm intervals and calculating the average. Statistical significance was assessed at a 5% level, and the association was determined using Spearman's rho correlation.

Results: The mean age of the study population was 55.7±11.05 years. Among them, only 37 (24.3%) showed the presence of calcification in the breast arteries. The mean CIMT was 0.92±0.25 mm in the BAC (+) group and 0.72±0.24 mm in the BAC (-) group (p-value=0.001).

Conclusion: The authors developed a BAC grading method after studying various previous studies and the present study found a significant positive correlation between the presence of BAC and CIMT.

Keywords: American cancer society, Common carotid artery, Craniocaudal view, Mediolateral oblique view, Ultrasonography

INTRODUCTION

Atherosclerosis, the leading cause of cardiovascular mortality, is a chronic inflammatory disease caused by hyperlipidemia and lipid oxidation. It affects the intima of vessels, from the aorta to the coronary arteries, leading to the formation of intimal plaques [1]. Atherosclerosis can be detected through imaging techniques such as radiographs and Computed Tomography (CT), where arterial calcifications are observed, or through ultrasound, which shows an increase in Carotid Intima Media Thickness (CIMT) [2]. Screening mammograms are performed on asymptomatic women to detect breast malignancies at an early and treatable stage. According to ACS guidelines, average-risk women between the ages of 40 and 44 should undergo screening mammograms, while women aged 45 and above should have them annually. High-risk women should start screening from the age of 30 [3]. Breast Arterial Calcifications (BACs) are commonly seen as incidental findings on mammograms. They are benign dystrophic calcifications found in the tunica media of small to medium-sized muscular arteries in the breast. They are also known as Mönckeberg calcifications or arteriosclerosis [2]. CIMT is a well-established surrogate marker of atherosclerosis and is associated with cardiovascular risk factors and outcomes. It is a non-invasive measurement of the thickness of the innermost two layers of the arterial wall, the tunica intima and tunica media. CIMT is obtained through B-mode ultrasonography, which captures still images. Increased CIMT indicates diffuse arterial wall thickening, reflecting the presence of atherosclerosis [4]. It is also used to monitor the progression of atherosclerosis for early medical intervention. Vascular calcifications in the breast and increased CIMT have both been recognised as potential markers of a woman's risk for coronary artery disease. Therefore, for patients incidentally detected with BAC during screening mammography for breast cancer, the possibility of future cardiovascular events should be considered [4].

The aim of present study was to assess BAC, using the Grade system, and evaluate the association between BAC and CIMT in women undergoing screening mammography.

MATERIALS AND METHODS

A cross-sectional study was conducted on 152 women who underwent screening mammography at the Department of Radiodiagnosis, Amala Institute of Medical Sciences, Thrissur, Kerala, India from May 2021 to October 2022. Informed consent was obtained from all participants, and the study received approval from the Institutional Ethical Committee on 26/04/2021 (Ref. no. 17/IEC/21/ AIMS-08). Consecutive sampling was performed.

Inclusion criteria: Women undergoing mammography between the ages of 31 years and 89 years.

Study Procedure

After obtaining relevant clinical and past history information, as well as informed consent, standard Mediolateral Oblique (MLO) and Craniocaudal (CC) views were obtained using the Siemens MAMMOMAT 1000 mammography unit. Breast Arterial Calcification

(BAC) was defined as the presence of tortuous, parallel linear calcified deposits along the vessel wall observed on at least one view of a mammogram, which is an incidental finding [2]. The mammogram images were assessed for the presence and grading of BAC. The scoring/grading system for breast arterial calcifications used in present study was developed by the authors after reviewing multiple articles [2-6]. For women with BAC, the number, length, and density of calcified vessels were evaluated using the following criteria:

The number of calcified vessels in each breast: (average of both breasts)

- Score 1: <2 vessels-1
- Score 2: 2-4 vessels- 2
- Score 3: >4 vessels-3

Length of the calcified vessels; (average of both breasts)

- Score 1: ≤3 cm-1
- Score 2: 4-6 cm-2
- Score 3: ≥7 cm-3

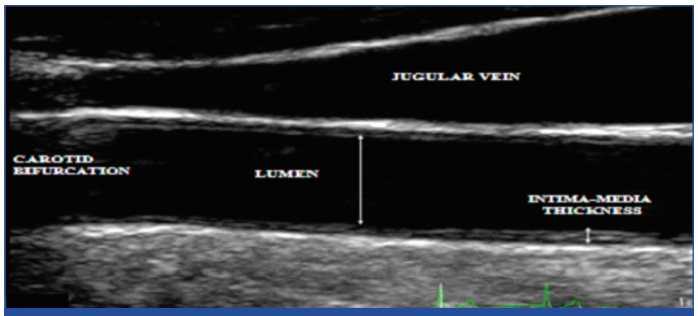
Density of a calcified vessel in its densest part;

- Score 1: BAC with clear lumen-1
- Score 2: BAC with clouded lumen-2
- Score 3: Dense BAC with non visualisation of lumen-3

The BAC grade was calculated by summing these three numbers and graded as:

- Grade-I (mild): Score ≤3
- Grade-II (moderate): Score 4-6
- Grade-III (severe): Score ≥7

Carotid Intima Media Thickness (CIMT) was assessed using an 8-13 MHz linear transducer. CIMT measurements were taken from two contiguous sites at 1 cm intervals, and the average of the two measurements was used for analysis. The CIMT measurement was reported as the average of the right and left Common Carotid Artery (CCA) [Table/Fig-1].



[Table/Fig-1]: Ultrasound image showing Carotid Intima Media Thickness (CIMT).

STATISTICAL ANALYSIS

Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version 23.0. Continuous measurements were presented as mean±standard deviation, and categorical measurements were presented as number (%). Significance was assessed at a 5% level. The association between BAC and age was analysed using Fishers's-extract test. The association between different grades of BAC by mammography and CIMT was analysed using Spearman's rank correlation. The association between BAC and CIMT was analysed using the Chi-square test.

RESULTS

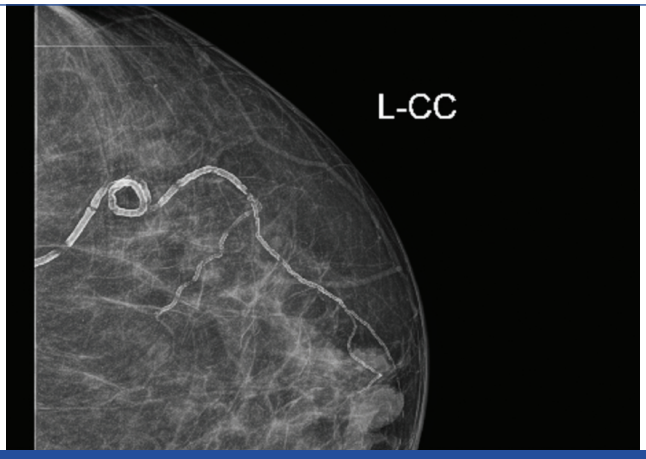
The mean age of the patients was 55.77±11.05 years. Among them, only 37 showed the presence of calcification in the breast arteries. The most commonly affected age group was 51-60 years [Table/Fig-2]. The majority of women showed a moderate grade of BAC [Table/Fig-3,4]. On the right side, the minimum CIMT noted was 0.3 mm, and on the left side, it was 0.1 mm. The maximum CIMT on the right side was 1.9 mm, and on the left side, it was 1.8 mm. The mean CIMT on the right side was 0.7 mm (0.4 sd), and on the left side, it was 0.7 mm (0.2 sd), with a total mean CIMT of 0.7 mm. Using a cutoff of ≤0.8 mm as normal CIMT [2], approximately 97 (63.8%) of the total subjects had CIMT ≤0.8 mm, and around 55 (36.2%) had CIMT > 0.8 mm [Table/Fig-5]. There was a significant difference in CIMT between the BAC positive and negative groups, with a p-value of <=0.05 [Table/Fig-6]. Logistic regression analysis between mean CIMT and BAC grades showed that there was no increase in CIMT with an increase in the grade of BAC [Table/Fig-7].

Age (years)	BAC		Total	p-value (Fisher-exact test)
	No	Yes		
31-40	10 (6.5%)	0	10 (6.5%)	0.0001
41-50	43 (28.3%)	1 (0.7%)	44 (28.9%)	
51-60	41 (26.9%)	10 (6.5%)	51 (33.6%)	
61-70	12 (7.9%)	15 (9.8%)	27 (17.8%)	
>70	9 (5.9%)	11 (7.2%)	20 (13.2%)	
Total	115 (75.7%)	37 (24.3%)	152 (100%)	

[Table/Fig-2]: Frequency of age distribution between BAC positive and BAC negative. Values presented as n (%).

Grading	Count	Percentage (%)
I	2	5.4
II	26	70.2
III	9	24.3

[Table/Fig-3]: Grading of BAC.



[Table/Fig-4]: Grade-III BAC according to BAC grading.

BAC	CIMT		Total	p-value (Chi-square test)
	≤0.8 (mm)	>0.8 (mm)		
Present	15 (40.5%)	22 (59.4%)	37 (24.3)	0.0001
Absent	82 (71.3%)	33 (0.28%	115 (75.6%)	
Total	97 (63.8%)	55 (36.18%)	152 (100%)	

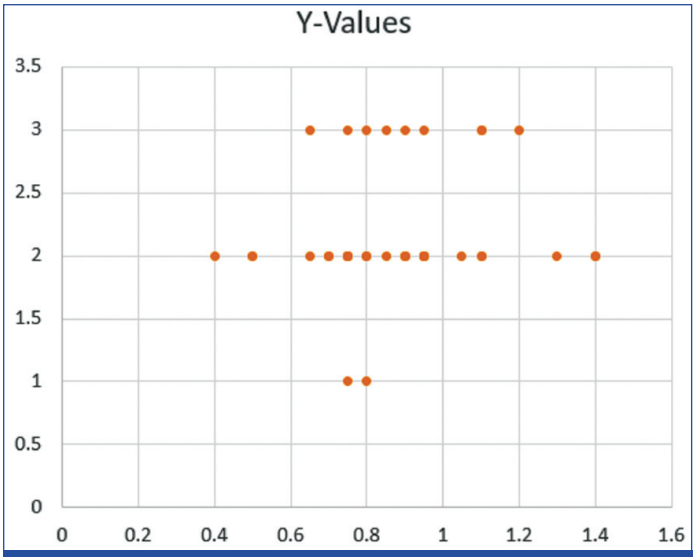
[Table/Fig-5]: CIMT in BAC positive and negative women.

Variables	BAC	N	Mean	Std. Deviation	p-value (Chi-square test)
CIMT right	No	115	0.759130	0.4516822	0.043
	Yes	37	0.921622	0.3038047	
CIMT left	No	115	0.717391	0.2103718	0.047
	Yes	37	0.808108	0.3165600	

[Table/Fig-6]: CIMT values in BAC + and – women.

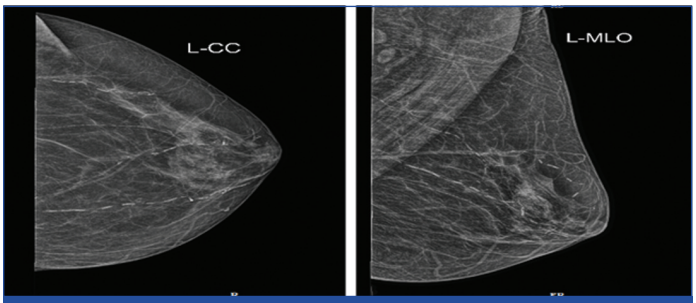
DISCUSSION

The BAC refers to calcium deposits along the vessel wall observed on mammograms, which is an incidental finding. These deposits



[Table/Fig-7]: r_s=0.16751, p (2-tailed)=0.3217.
There was a positive correlation between CIMT and BAC grade, but they are statistically insignificant. (No increase with an increase in grade)

occur in the middle layer of the vessel wall, leading to increased rigidity and stiffness of the vessel [Table/Fig-8] [2]. BAC detected on breast cancer screening mammograms may also be associated with disorders related to increased or accelerated atherosclerosis [7]. In the early stages, medial arterial calcifications appear punctate and then coalesce and become thicker, leading to linear tramtrack calcifications [8].



[Table/Fig-8]: Breast arterial calcification in a left breast in CC and MLO views.

The BAC is incidentally detected in only 9.1% of mammograms and is uncommonly seen before the age of 50 years [7]. The prevalence of BAC ranges from 9-17% and increases with age, particularly in women above 65 years of age. Increased parity has also been associated with an increase in BAC [9]. Kemmeren JM et al., recorded BAC in 9% of women who participated in a breast cancer screening program [5]. In present study, BAC was detected in only 24.3% of subjects, and there was only one case of BAC below the age of 50 years. Maas AH et al., demonstrated that the prevalence of BAC increased with advancing age, from 5% in the first quartile to 6% in the second quartile, 14% in the third quartile, and 20% in the fourth quartile. The odds ratio of women in the highest quartile of age having BAC was 4.7 (95% CI: 2.9-7.6) compared to women in the lowest quartile [10]. In present study, BAC was noted to increase with age and was mostly seen in women above 60 years of age.

Sankaran P et al., in their study on 100 women, found that there is an independent association between BAC in mammography and CIMT. Additionally, they found a statistically significant positive connection with CIMT, independent of age and menopausal state [2]. In the present study, CIMT did not show an increase in thickness with an increase in the grade of breast vessel calcification. Hanafi MG et al., in a study of 454 participants, showed that although individuals with BAC had a higher CIMT than the control group, there was no relationship between the grade of this calcification and carotid artery thickness [11].

Kadioglu A and Bahadir S, in their multi-modality study investigating the association of BAC, coronary artery calcification, and CIMT, found that BAC is strongly associated with aging. High BAC scores showed correlation with high CAC scores and also found a statistically significant correlation between BAC and cardiac risk factors like diabetes. Furthermore, in women younger than 60 years old, they suggested that the BAC scoring system can be used as an indicator of the presence of cardiovascular disease [12].

Akinola RA et al., in their study on 54 Nigerian women, found that although the presence of BAC in a mammogram is related to age, it may not be a reliable indicator or a relevant marker for cardiovascular diseases in women living in their environment [7]. Ali EA et al., in their study on 100 female patients, concluded that women over 60 who have BAC discovered accidentally via mammography should have their coronary atherosclerotic condition and risk of developing significant coronary artery disease further assessed [13]. In the present study, moderate grades of BAC were found to increase with age over 50 years. Since the majority of women over 40 years of age undergo screening mammography annually according to guidelines, our study suggests that the measurement of BAC may offer a non-invasive approach to risk stratify women for cardiovascular disease without additional radiation. Therefore, the inclusion of incidentally detected BAC in mammogram reports may help clinicians counsel and recommend lifestyle changes, cardiovascular risk assessment, and prevention of future cardiovascular events.

Limitation(s)

However, present study included a relatively small number of subjects, and most patients were post-mastectomy follow-up cases, which was a major limitation. The absence of a universally accepted method of grading BAC is another limitation.

CONCLUSION(S)

Hence, authors developed a BAC grading method after studying various previous studies. The effect of co-morbidities on CIMT thickness was not considered. This scoring criteria is only applied in a small population; therefore, before commenting on its accuracy, it needs to be tested in different settings or in different populations. Further, studies are warranted to determine the accuracy of this objective scoring system.

REFERENCES

[1] Berliner JA, Navab M, Fogelman AM, Frank JS, Demer LL, Edwards PA, et al. Atherosclerosis: Basic mechanisms: Oxidation, inflammation, and genetics. Circulation. 1995;91(9):2488-96.
[2] Sankaran P, Prajeeth N, Koteshwara P. Association of vascular calcification of breast with carotid intima media thickness. Pol J Radiol. 2019;84:335-59.
[3] Smith RA, Andrews K, Brooks D, DeSantis CE, Fedewa SA, Lortet-Tieulent J, et al. Cancer screening in the United States, 2016: A review of current American Cancer Society guidelines and current issues in cancer screening. CA Cancer J Clin. 2016;66(2):95-114.
[4] Yildiz S, Yildiz A, Ertug N, Kaya I, Yilmaz R, Yuksel E, et al. Association of breast arterial calcification and carotid intima-media thickness. Heart Vessels. 2008;23(6):376-82.
[5] Kemmeren JM, Beijerinck D, van Noord PA, Banga JD, Deurenberg JJ, Pameijer FA, et al. Breast arterial calcifications: Association with diabetes mellitus and cardiovascular mortality. Radiology. 1996;201:75-78.
[6] Hannawi SMA, Hannawi H, Al Salmi I. Carotid intima media thickness as a surrogate measure for cardiovascular disease in rheumatoid arthritis: Literature review. J Integr Cardiol. 2018;4(4):01-05. Doi: 10.15761/jic.1000252.
[7] Akinola RA, Ogbera OA, Onakoya JA, Enabulele CE, Fadeyibi IO. Mammograms and breast arterial calcifications: Looking beyond breast cancer: A preliminary report. BMC Res Notes. 2011;4(1):01-06.
[8] Cetin M, Cetin R, Tamer N, Kelekci S. Breast arterial calcifications associated with diabetes and hypertension. J Dia Comp. 2004;18:363-66.
[9] Ross R. The pathogenesis of atherosclerosis: A perspective for the 1990s. Nature. 1993;362:801-09.
[10] Maas AH, van der Schouw YT, Beijerinck D, Deurenberg JJ, Mali WP, van der Graaf Y. Arterial calcifications seen on mammograms: Cardiovascular risk factors, pregnancy, and lactation. Radiology. 2006;240(1):33-38.
[11] Hanafi MG, Sarikhani S, Sahraeizadeh A. An investigation into the association between arterial calcification in mammography and carotid intima-media thickness. Pharmacophore. 2017;8(5):47-53.

[12] Kadıoğlu A, Bahadır S. Breast arterial calcifications as an indicator of atherosclerotic cardiovascular disease: Comparative analysis of coronary computed tomography scoring systems and carotid intima-media thickness. Quant Imaging Med Surg. 2022;12(1):457-69.

[13] Ali EA, Fouad H, Razek NA, Saeed OM, Helmy SM. Evaluation of mammography detected breast arterial calcifications as a predictor of coronary cardiac risk. Egypt J Radiol Nucl Med. 2019;50(1). Doi: 10.1186/s43055-019-0095-7.

PARTICULARS OF CONTRIBUTORS:
1. Junior Resident, Department of Radiology, Amala Institute of Medical Sciences, Thrissur, Kerala, India.
2. Associate Professor, Department of Radiology, Amala Institute of Medical Sciences, Thrissur, Kerala, India.
3. Assistant Professor, Department of Radiology, Amala Institute of Medical Sciences, Thrissur, Kerala, India.
4. Senior Resident, Department of Radiology, Amala Institute of Medical Sciences, Thrissur, Kerala, India.
5. Professor and Head, Department of Radiology, Amala Institute of Medical Sciences, Thrissur, Kerala, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr, Aleena Khan,
Junior Resident, Department of Radiology, Amala Institute of Medical Sciences, Thrissur-680555, Kerala, India.
E-mail: khanalina3@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Feb 04, 2023
- Manual Googling: Apr 27, 2023
- iThenticate Software: Jul 22, 2023 (13%)

ETYMOLOGY: Author Origin

EMENDATIONS: 7

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Jan 30, 2023**
Date of Peer Review: **Apr 15, 2023**
Date of Acceptance: **Jul 27, 2023**
Date of Publishing: **Sep 01, 2023**