Mammography-based Breast Arterial Calcification Screening

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Purpose

In this study, we present a demographic analysis of Artificial Intelligence (AI)-enhanced detection of Breast Arterial Calcifications (BAC) in a large screening population across 15 sites in a prospective study and evaluate the logistics of such screening.

Background

BAC on mammography has been historically overlooked and underreported as an "incidental finding". Due to the success of mammography as a screening platform and the known gaps in cardiac screening for women, particularly young women, there has been an emerging interest in the Australian, Canadian, European and United States literature to use the presence and extent of BAC as a potential method for identifying women that may need cardiac screening for medical optimization[1-8].

Methods

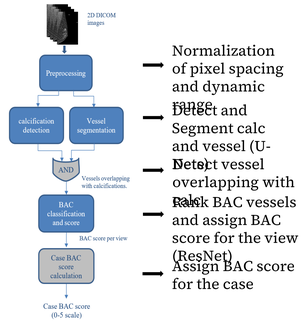
Sequentially accrued 2D mammograms from 117,189 asymptomatic screening women during a 7-month period (03/24/2023 - 11/1/2023) across 15 screening sites were analyzed using a deep learning AI algorithm specifically designed for BAC detection.
Age of women screened ranged from 20 to 100 years of age, with a median age of 56. The study assessed overall prevalence of BAC, as well as distribution of BAC across four age groups: <50, 50-59, 60-69, ≥70.

Methods cont.

The AI model was trained using an internal dataset of 2D mammograms to detect BAC based on expert annotation and provides a BAC of 0-5 according to the total area of BAC and its associated density.
Prior to the study, the accuracy of the AI algorithm was validated on a validation dataset of 2D mammograms from 8,881 women. There was no overlap between the training, validation and 117,189 women prospective study datasets.

AI BAC Algorithm

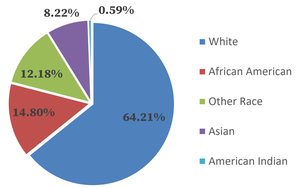
- Deep convolution neural network models
- Trained to detect BAC on 2D Full-Field Digital Mammography (FFDM) and 2D synthetic images from 3D mammography
- BAC Scores (0-5)



BAC Score definition:
0: No BAC visible
1: Short BAC vessel(s) with faint BAC
2: Short BAC vessel(s) with dense BAC
3: One long BAC vessel and moderately dense BAC
4: One long BAC vessel and dense BAC
5: Multiple long BAC vessels and dense BAC

Methods cont.

Number of Sites	15
Time Period	3/24/2023 - 11/1/2023
Number of Patients	117,189
Median Age	56



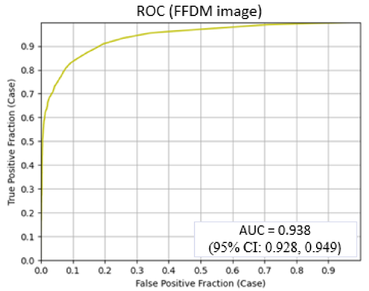
Results

The AI algorithm achieved an area under the ROC curve (AUC) of 0.938 (95% CI: 0.928 - 0.949) on the FFDM validation dataset and an AUC of 0.925 (95% CI: 0.904, 0.945), indicating high accuracy in BAC detection.
In the prospective study with 117,189 women, the overall prevalence of BAC detected by the AI algorithm with a BAC score >1 was 14.8% (95% CI: 14.8-14.9%), 4.2% (95% CI: 4.1- 4.3%) in women <50, 9.0% (95% CI: 8.6 % - 9.1%) in women 50-59, 19.9% (95% CI: 19.4 % - 20.2%) in women 60-69, and 40.7% (95 CI: 39.9 - 41.4%) ≥70.

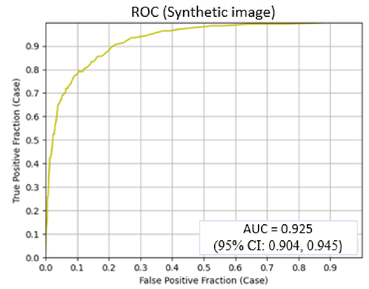
Results cont.

BAC Algorithm Validation Results

Test Dataset	Total Cases	Age	Date
FFDM Images	5899	57 (35-94)	2014-2021



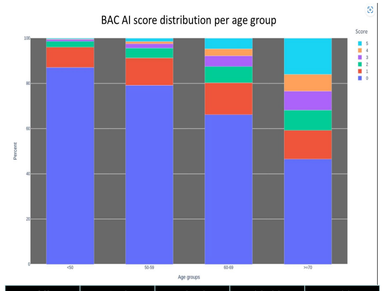
Test Dataset	Total Cases	Age	Date
2D Synthetic Images	2982	62 (35-86)	2015-2021



Results cont.

Prevalence of BAC detected by the AI Algorithm

Prevalence by age group (BAC score>1)



All	< 50	50-59	60-69	>69
14.8% (14.8% - 14.9%)	**4.2%** (4.1% - 4.3%)	**9.0%** (8.6% - 9.1%)	**19.9%** (19.4% - 20.2%)	**40.7%** (39.9% - 41.4%)

Conclusion

AI based BAC screening on mammography can be performed autonomously in an accurate manner as evidenced by our results in a large screening population across 15 sites.

The AI Algorithm demonstrated high accuracy in BAC detection, with a prevalence and distribution of BAC increasing with age as expected in a screening population. The overall prevalence of BAC in our screening population was around 15%.

Our results suggest that AI can standardize BAC detection at scale, potentially improving efficiency and reducing inter-observer variability.

Future Work

Future work involves longitudinal tracking of patients with and without BAC to identify associated cardiovascular risk factors and standardized work-ups to guide primary care physicians in managing patients with BAC detected on screening mammography.

References

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