

The value of the craniocaudal mammographic view in breast cancer detection: A preliminary study

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Abstract

Mammography is considered a reliable modality in detecting early breast lesions. Many studies indicated that two-view (mediolateral oblique (MLO) and cranio-caudal (CC)) mammography provides radiologists with more information to detect breast cancer than a single medio-lateral oblique (MLO). Nevertheless, there have been growing concerns about the effects of radiation exposure on patients who absorb approximately double radiation dose with a routine two-view. Although one view MLO was proved to be less effective than two views in detecting cancer lesions, the value of cranio-caudal view has never been established. This paper aims to assess the value of the single cranio-caudal view mammogram in the detection of breast cancer. 129 radiologists were asked to report 60 two-view mammograms of the left and right breasts and 55 radiologists assessed a further set of 55 single cranio-caudal views. Participants were asked to search for the presence of any breast lesions and provide confidence scores for their decisions. The sensitivity, specificity and localization sensitivity of each reader were analysed along with JAFROC (jackknife free response receiver operating characteristics) figure of merit and ROC (receiver operating characteristics) values. Results showed that two-view mammograms were more effective in detecting malignant nodules than single cranio-caudal view in terms of sensitivity, localized-sensitivity, ROC and JAFROC. The single cranio-caudal view had a higher specificity as compared to two-view mammography.

Keywords

Cranio-caudal mammogram, two-view mammogram, breast nodule detection, ROC, JAFROC

1. Introduction

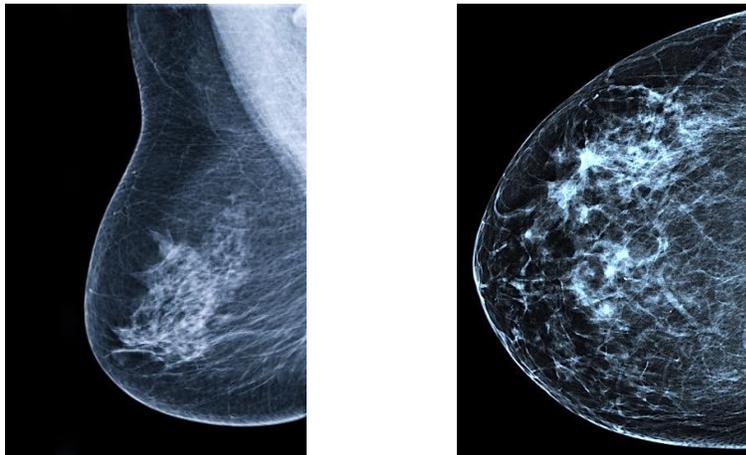
Breast cancer is one of the most common types of cancer diagnosed in women. According to [Australian Institute of Health and Welfare \(2010\)](#), the rate of female developing breast cancer before 85 years old is one in nine and the risk of mortality due to this disease is one in thirty seven. Mammography with reasonably high sensitivity (60%–80%) and specificity (73%–95%) has been considered to be a reliable modality in detecting early breast lesions through abnormal signs such as masses, calcifications, bilateral asymmetry and distortion ([Maggio, 2004](#); [Kavanagh et al., 2000](#)). When breast screening was firstly introduced, a single medio-lateral oblique (MLO) view of each breast was considered as the routine examination and only later was the caudo-cranial (CC) added as a subsequent view. [Wald et al. \(1995\)](#) through a randomized controlled trial found that two view mammography (CC plus MLO) was able to detect breast cancer signs, especially small lesions, better than one view image, with a 24% increase in sensitivity (4). Other studies by [Blanks, Moss & Wallis \(1997\)](#), [Law & Faulkner \(2002\)](#) and [Seigneurin, Exbrayat, Labarere & Colonna \(2009\)](#) also indicated that standard two view breast radiography at subsequent screens provided radiologists with more information in detection of cancer than only the MLO. Nevertheless, there has been growing concerns about the effects of radiation exposure on patients who absorb approximately double the radiation dose with a routine two-view rather than a single projection (Law & Faulkner, 2002). Although one view MLO was proved to be less effective than two views, the role of one view CC in diagnosis of breast cancer has not yet been explored.

The aim of this study is to assess the value of cranio-caudal mammogram in screen-detected breast cancers.

2. Methods and Materials

Two retrospective experiments were conducted at the 2011 Royal Australian and New Zealand College of Radiologists Breast Imaging Group meeting in Hobart. In the first experiment, 60 two-view mammograms (CC&MLO) of both breasts comprising 20 malignant lesions and 40 cancer-free cases were collected. The second study consists of 55 single CC views (either left or right breast) of which 23 contained malignant lesions. All lesions were biopsy proven.

Figure 1: The two view mammogram: Medio-lateral oblique (MLO) (left) and Cranio - caudal (CC) (right)



The portrait Eizo Radiforce GS510 Specs (21.3 inch) monochrome high- class LCD diagnostic monitors were utilized to display images in the both experiments. Average viewing distance was approximately 40 cm from the display and the ambient light in the reading room ranged from 20 to 30 lux.

129 radiologists who currently report breast images in Australia and New Zealand were involved in the first experiment and 25 readers were recruited for the second experiment. 14 radiologists involved in both sessions. The average experience of reporting mammography of participants was approximately 10 years (Figure 2).

Figure 2: Participant demographic details

	Number of readers	Average mammo reading experience (years)	Average number of mammo readings per year	Profession			
				General radiologist	Breast specialist	Radiographer	Radiology resident
Two view Experiment	129	9	4790.6	111	13	4	1
One view Experiment	25	10.9	5008.6	23	2	0	0
Common readers between two experiments	14	11.5	6478.5	12	2	0	0

The same general procedure was used for both experiments. Participants were asked to undergo one session of image interpretation and decide on the presence or absence of breast lesions on each image. Radiologists were allowed to digitally manipulate the images (panning, zooming). When the readers were ready to provide a decision, they were asked to indicate the confidence score from 1 to 5; whereby 1 representing complete confidence that the case was normal, 2 was dedicated for a benign finding and 3 to 5 represented a malignant lesion. For the images with confidence scores from 2 to 5, lesions locations were indicated by using a mouse-controlled cursor to mark the coordinates (x, y). The readers moved on to the next case with a mouse-click when they were certain that they had reported all lesions. There was no restriction on search time and number of mouse-clicks. Clinical history and information on the distribution of normal and abnormal cases were not provided to participants.

In term of data analysis, the locations and the confidence levels reported by observers were classified into true positive, false positive, true negative and false negative basing on truth of the cases (Figure 3). The localizations were assessed based on visual angle of 1 degree between the mouse-click coordinates and nodule center.

Figure 3: Classification of confidence levels according to the truth of the cases

Cases	Confidence levels	Transferred data
Normal/Benign	1, 2	True negative
	3, 4, 5	False positive
Malignant	1, 2	False negative
	3, 4, 5	True positive

As participants were allowed to indicate more than one finding per case, the confidence scores were analyzed by using the receiver operating characteristics (ROC) ([Metz, 2006](#)) and jackknife free response receiver operating characteristics (JAFROC) methods ([Chakraborty, 2004](#)). ROC provides the comprehensive description of participant performance in term of sensitivity combined with specificity while JAFROC method allows quantitative analysis of observer data when radiologists interpret images, which could contain more than one lesion and a location can be reported for each perceived lesion.

T-test was utilized to compare all reader/all case metrics and DBM MRMC ROC (Dorfman Berbaum Metz Multi Reader Multi Case) was used for same-reader same-case analysis. In addition sensitivity, specificity and localization sensitivity of each reader were calculated with the data collected from both sessions of the study.

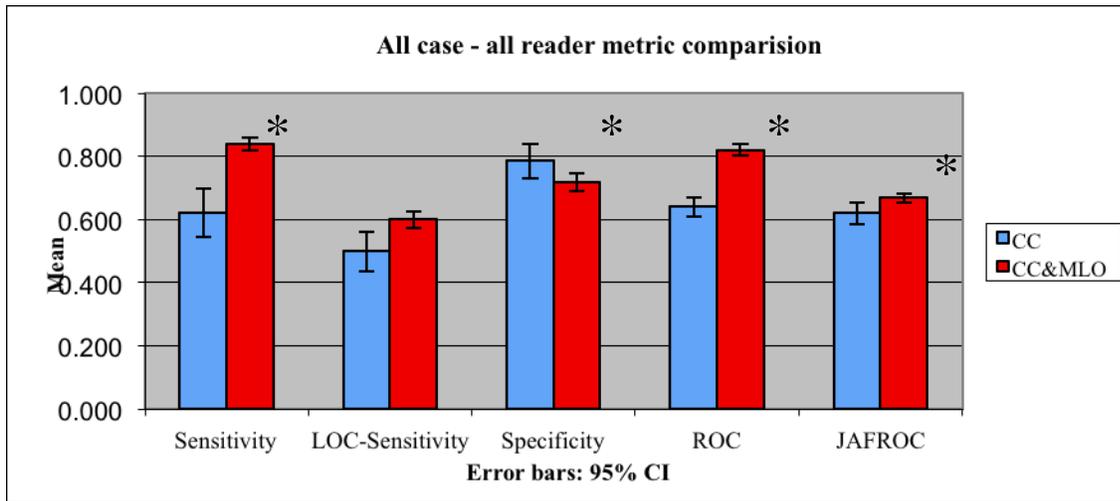
3. Results

3.1. All cases/all readers:

The results showed that two view (CC & MLO) mammography demonstrated higher efficacy in detecting malignant cases in terms of sensitivity ($0.84 > 0.62$; $p < 0.001$), localized-sensitivity ($0.6 > 0.5$; $p = 0.006$) as compared to one view. Whilst two-view verified a higher sensitivity than

single crano-caudal mammogram, CC showed higher (non-significant) specificity (0.79) than CC & MLO (0.72) ($p=0.065$) (Figure 4).

Figure 4: Averaged sensitivity, specificity, localized sensitivity, ROC and JAFROC based on data of one view (CC) and two view (CC&MLO) experiments.



* demonstrates the significant difference in the metric comparison between one view and two views.

	Sensitivity	LOC-Sensitivity	Specificity	ROC	JAFROC
CC	0.622	0.499	0.787	0.740	0.620
CC&MLO	0.840	0.600	0.720	0.820	0.670
P values	<0.001	0.006	0.065	<0.001	0.020

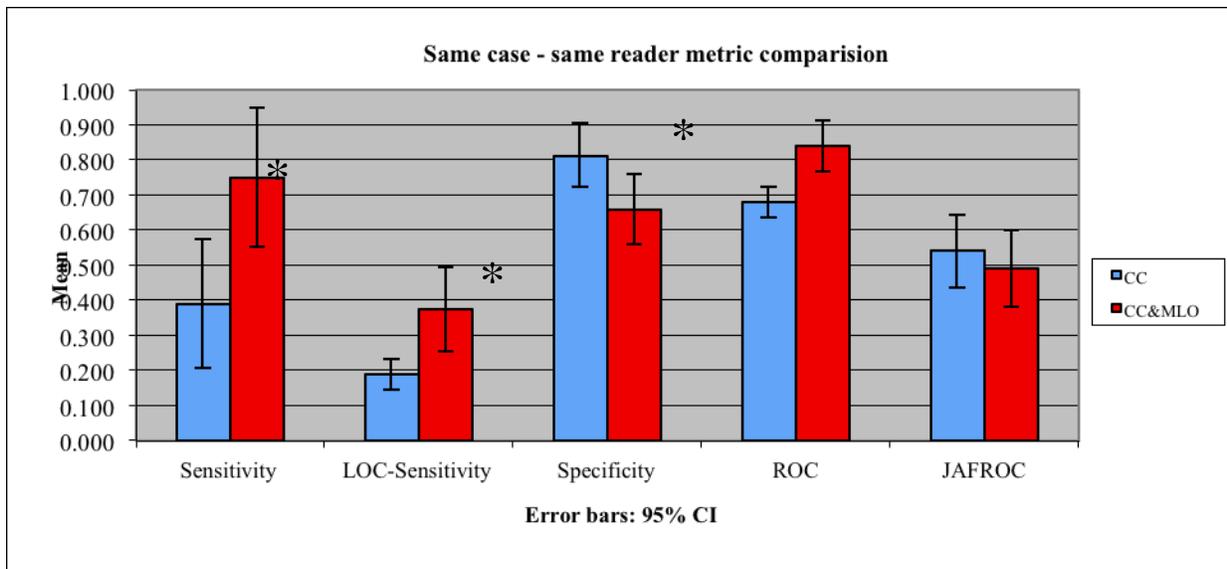
There were also significant differences found in ROC ($0.82 > 0.74$; $p<0.001$) and JAFROC ($0.67 > 0.62$; $p=0.02$) across one view and two views. Unpaired comparisons between two experiments indicated that radiologists localized malignant lesions more accurately in two views than in one view.

3.2. Same cases – same readers:

Of 15 cases and 14 readers common between the one view and two view experiments, there

was no significant difference in ROC and JAFROC. However, noticeable changes have been demonstrated in the specificity and the localization-sensitivity. CC view continued showing higher capability in identifying normal cases ($0.81 > 0.66$; $p=0.001$) while CC-MLO was twice more sensitive than CC in lesion detection ($0.75 > 0.39$; $p=0.16$), although the level of localization of both experiments were relatively low (less than 0.5, $p=0.016$) (Figure 5).

Figure 5: Averaged sensitivity, specificity, localized sensitivity, ROC and JAFROC based on data of same readers and same cases in one view (CC) and two view (CC&MLO) experiments.



* demonstrates the significant difference in the metric comparison between one view and two views

	Sensitivity	LOC-Sensitivity	Specificity	ROC	JAFROC
CC	0.390	0.189	0.812	0.680	0.540
CC&MLO	0.750	0.375	0.659	0.840	0.490
P values	0.016	0.016	0.001	0.110	0.675

4. Breakthrough work

The results demonstrate that malignant lesions tended to be missed with a single CC view compared with two-view mammography. This was shown to be true with all the analytical

metrics used. However the enhanced specificity of CC may suggest some benefit for low risk women having a follow-up breast screening.

There were some limitations with the work, one being the laboratory effect. In observer experiments, radiologists were not affected by the pressure of being responsible for patients hence the reporting of some readers might be different from clinical reporting. Besides, the absence of CC views of the other breast in the second experiment might be a reason why the sensitivity of CC view was relatively low. Therefore, more studies with adequate views and larger number of cases are necessary for more accurate analysis.

5. Conclusion

Radiologists have a better performance in detection of breast nodules when they have access to both the MLO and CC views. Whilst the CC view alone may miss important diagnostic information, some benefit for screening programs may be evident with single view examinations. This requires further investigation.

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